San Francisco Airports Commission

ENVIRONMENTAL IMPACT REPORT– SAN FRANCISCO AIRPORT EXPANSION

APRIL 1973

VOLUME I

FINAL REPORT

FINAL ENVIRONMENTAL IMPACT REPORT

SAN FRANCISCO INTERNATIONAL AIRPORT EXPANSION PROGRAM

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FOREWORD

An environmental impact report is an informational document which, when fully prepared in accordance with the California Environmental Quality Act of 1970 (CEQA) as amended and the Guidelines for implementation of the CEQA (Guidelines) as prepared by the Resources Agency of California, will inform public decision makers and the general public of the environmental effects of projects they propose to carry out or approve (Section 15012, Guidelines).

This report has been prepared in accordance with the CEQA (Public Resources Code Sections 21000-21174), which states, in part, as follows:

> "Section 21151. All local agencies shall prepare, or cause to be prepared by contract, and certify completion of an environmental impact report on any project they intend to carry out or approve which may have a significant effect on the environment."

Data used in this report were compiled from studies and reports listed in the Bibliography. The report incorporates information obtained from agencies and individuals, including three public hearings held on March 6, 8, and 28 of 1973. The report format has been organized in accordance with the latest guideline prepared by the Resources Agency of the State of California dated February 3, 1973; it varies from the format of the draft EIR which was prepared prior to the publication of that Guideline.

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Section 1

DESCRIPTIONS

A. DESCRIPTION OF PROJECT

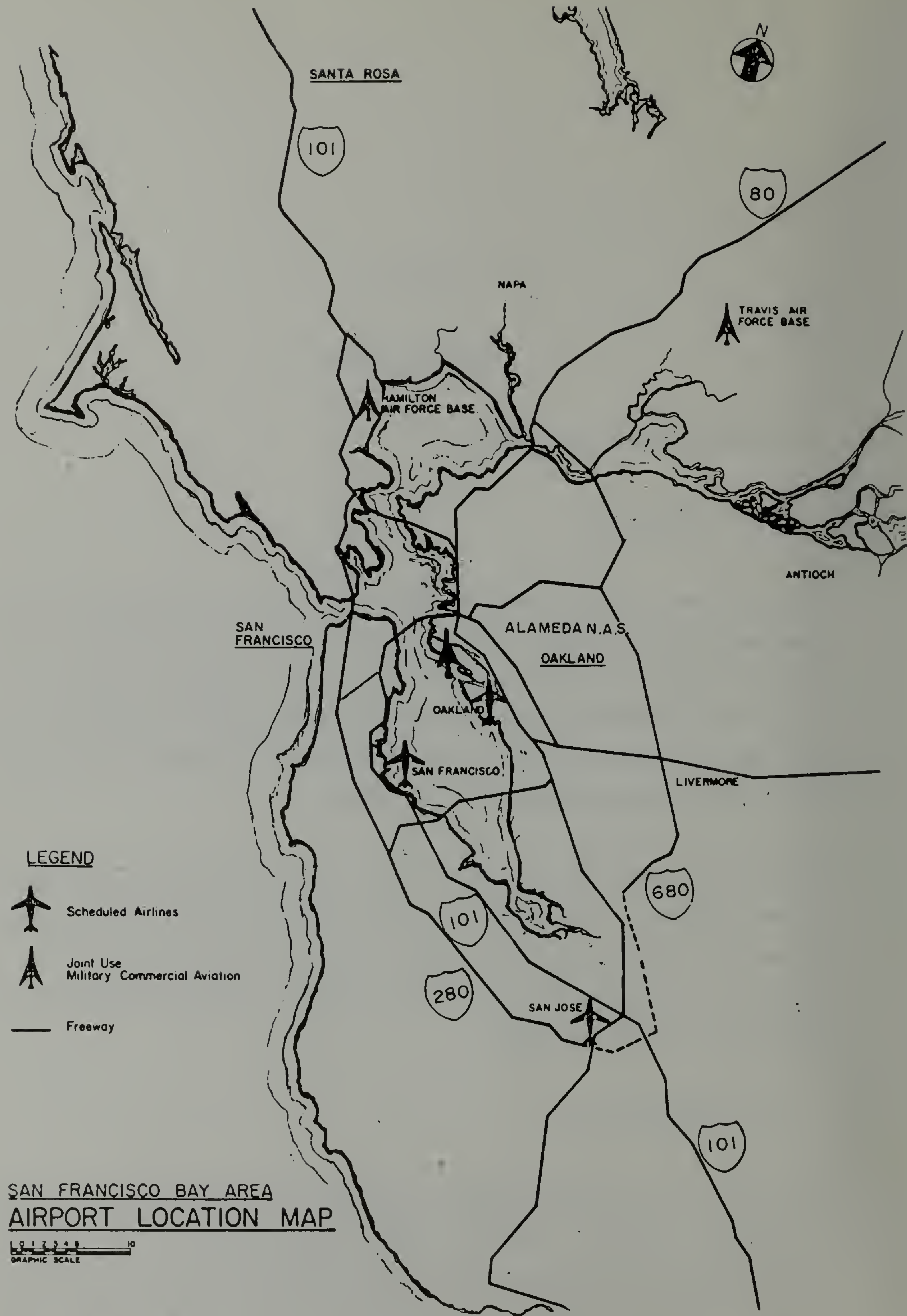
1. LOCATION

The San Francisco International Airport is located on the San Francisco peninsula along the shores of San Francisco Bay. It is 15 miles south of the City of San Francisco and the communities of Millbrae, South San Francisco, San Bruno and Burlingame are adjacent to the airport property. The San Francisco International Airport Expansion Program will take place within the existing airport boundaries.

The location and boundaries of the San Francisco International Airport are shown on Figure 1-1 (enclosed in case in the back of this report) which also shows the existing topography, San Francisco Bay and adjacent cities. Figure 1-2 shows the location of San Francisco International Airport in relation to the entire Bay region.

2. OBJECTIVES

The objectives of the Expansion Program are to create one of the most beautiful, convenient, compact and safe airports in the world, close to a major metropolitan area, where total transportation time would be minimized. The airport plans are directed toward providing facilities which will facilitate the handling of a predicted 31,000,000 passengers per year by 1985 while improving the operational efficiency and safety of the airport and protecting or improving the surrounding environment.



SANTA ROSA
101
80
NAPA
TRAVIS AIR FORCE BASE
HAMILTON AIR FORCE BASE
ANTIOCH
SAN FRANCISCO
ALAMEDA N.A.S.
OAKLAND
OAKLAND
SAN FRANCISCO
LIVERMORE
LEGEND
Scheduled Airlines
Joint Use Military Commercial Aviation
Freeway
680
101
280
SAN JOSE
101
SAN FRANCISCO BAY AREA
AIRPORT LOCATION MAP
GRAPHIC SCALE

Figure 1-2.

3. SUMMARY OF TECHNICAL, ECONOMIC AND ENVIRONMENTAL CHARACTERISTICS

The principal characteristic of the Expansion Program is that it primarily involves the enlargement and improvement of the terminal area. It provides for an increase in the number of aircraft parking gates from 56 to 80 with 54 of them sized to accommodate the larger jet aircraft. The vehicle parking garage at the terminal area is being increased to a capacity of 7,300 from its present capacity of 3,300. Access and service facilities are also being improved. No additional runways are being provided although improvements to existing runways and taxiways and the lengthening of runway 28R over existing fill are included.

The estimated cost of the Expansion Program is $390,000,000 and will be financed in part by General Obligation bonds ($98,000,000) and in part by revenue bonds, operating revenues and ADAP funds. All bonds will be repaid by income received from the airlines, from the automobile parking lots and from other concessions. A complete discussion of the financial aspects of the Expansion Program is contained in the document "Financial Feasibility/Rates and Charges Analysis" March 1973.

The proposed Expansion Program is divided into two time phases:

- Phase I: Those projects that are either under construction now or have been completed already.
- Phase II: Those projects for which detailed planning is underway and that can be accomplished between now and the end of 1981.

The program is further divided functionally into the Terminal, Airside, and Landside Areas. Brief descriptions and budgets for each subdivision are presented in the following paragraphs. A budget summary of the projects and a more complete description of each can be found in Appendix A, together with a brief assessment of each individual project's impact.

Terminal Area

Figure 1-3 indicates the various terminal area projects by showing the project numbers on a Terminal Area layout. The Terminal Area consists of six project groups: North Terminal Complex, East Terminal Complex, South Terminal Complex, Terminal Support Facilities, Ground Transportation Complex, and Ground Transportation Support Facilities.

North Terminal Complex. The North Terminal Complex is an entirely new terminal facility consisting of a main terminal building with frontal gates along its entire length and three satellite boarding areas linked to the terminal by elevated connectors. Twenty-nine gate positions are presently provided in this complex. Boarding Area J is sited for possible future construction.

The specific projects for the North Terminal Complex are:

• Phase I			
	T1	Demolition of Cargo Buildings	$ 300,000
	T2	North Terminal Foundations	4,000,000
• Phase II			
	T3	North Terminal Structure	28,000,000
	T4	Boarding Areas H and I and Connector	19,100,000
	T5	Boarding Area G and Connector	4,300,000
			$55,700,000

East Terminal Complex. The East Terminal Complex incorporates the existing Central Terminal Building, new frontal gates extending north and south along the front of the present Northeast and Southeast Courts, and two satellite boarding areas linked to the terminal by one elevated connector. This complex provides 18 gate positions and has as specific projects:

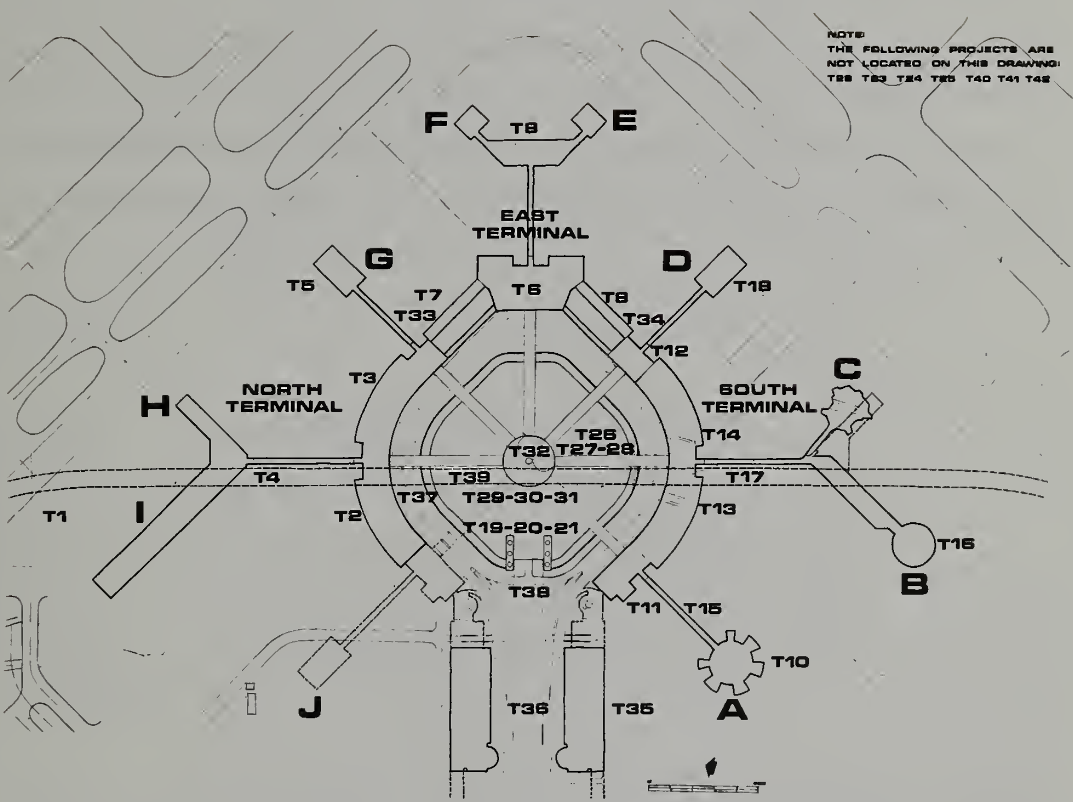


Figure 1-3. Terminal Area Projects

- Phase II

T6	Existing Terminal Additions and Modifications	$12,800,000
T7	Northeast Frontal Gates	2,500,000
T8	Southeast Frontal Gates	2,700,000
T9	Boarding Areas E and F and Connector	7,500,000
		$25,500,000

South Terminal Complex. The South Terminal Complex is an enlargement and extension of the present South Terminal Building, providing frontal gates along its entire length plus four satellite boarding areas with three new elevated connectors. Three of these boarding areas, A, B, and D, are new; the fourth, Boarding Area C, is a redesignation of old Pier f. This complex will provide 33 gate positions. Specific projects are:

- Phase I

T10	Boarding Area A	$ 4,450,000

- Phase II

T11	South Terminal West Addition	9,200,000
T12	South Terminal East Addition	6,300,000
T13	Frontal Additions and Frontal Gates	8,500,000
T14	Modifications	10,700,000
T15	Connector A	2,300,000
T16	Boarding Area B	8,000,000
T17	Connector B-C	4,300,000
T18	Boarding Area D and Connector	4,600,000
		$58,350,000

Terminal Support Facilities. The Terminal Support Facilities consist of those projects required to make the Terminal Complexes fully functional. These projects are:

- Phase II

T19	Central Heating and Chilling Plant	$ 5,000,000
T20	Utility Distribution	1,000,000
T21	Interline Baggage Tunnel	2,800,000
T22	People Mover Systems (Terminal)	7,800,000
T23	Terminal Furniture	500,000
T24	Art Enrichment	2,000,000
T25	Demolition of Piers b, c, d, e, ff, g	1,250,000
		$20,350,000

Ground Transportation Complex. The Ground Transportation Complex lies in the center of the Terminal Area and contains those facilities needed for the transfer of passengers from the ground mode of transportation to the air mode, or vice versa. This complex will provide a five-level parking structure with a modern revenue-collection system, provisions for future additions of a BART subway and station, an underground tunnel for utilities and future interline baggage systems, a central water heating and chilling plant to supply the terminal air-conditioning systems, a 200-foot-diameter central open area, a 200-foot-high tower supporting a two-level observation deck and concession area below the cab on the new control tower recently approved by Congress, a Passenger Distribution Center at the sixth level, and radial structures from the central core to the various terminal buildings to support the People Mover System (PMS). This development contains the following specific projects:

• Phase I			
	T26	Fifth-Level Addition to Existing Garage	$ 1,967,000
• Phase II			
	T27	Existing Garage Additions and Modifications	5,600,000
	T28	Existing Garage — PMS Structure	3,600,000
	T29	Garage Addition	28,000,000
	T30	Garage Addition — PMS Structure	500,000
	T31	Passenger Distribution Center	8,100,000
	T32	Control Tower and Ring	3,800,000
	T33	Northeast Court Parking Deck	700,000
	T34	Southeast Court Parking Deck	600,000
	T35	Rental Car Facility	5,000,000
			$57,867,000

Ground Transportation Support Facilities. In addition to the foregoing, the Ground Transportation Support Facilities are required to make the Terminal Area a fully functioning facility. These are:

- Phase I

T36	Entry Roads and West Underpass	$ 3,008,000
T37	Terminal Roads and East Underpass	10,904,000

- Phase II

T38	Upper Terminal Road Section	900,000
T39	BART Access Provision	2,000,000
T40	People Mover System (Garage)	14,500,000
T41	Road Graphics	600,000
T42	Grading, Irrigation, and Planting	850,000
		$32,762,000

The budget estimates for the People Mover System items (T22 and T40) are allowances incorporating the horizontal-elevator concept recommended by the San Francisco Airport Architects, even though the exact system selection has not been made.

Airside Area

The projects for Airside Area represent improvements to the runway and taxiway systems and the aprons to make the airport safer and more efficient to operate. They are depicted in Figure 1-4 • The work includes runway extensions, high-speed exit taxiways, taxiway lighting, and aprons for the new gate locations. Specific projects are:

- Phase I

A1	Taxiway B and Apron	$ 2,755,000
A2	Extension of Taxiway B and Apron	1,022,000
A3	Taxiway G and L	624,000
A4	South Terminal Apron Addition	881,000
A5	Boarding Area A Apron	590,000
A6	Taxiways D, E, F, G — Lighting	225,000
A7	Taxiway B — Centerline Lighting	149,000
A8	Remote Transmitter Facility	104,000

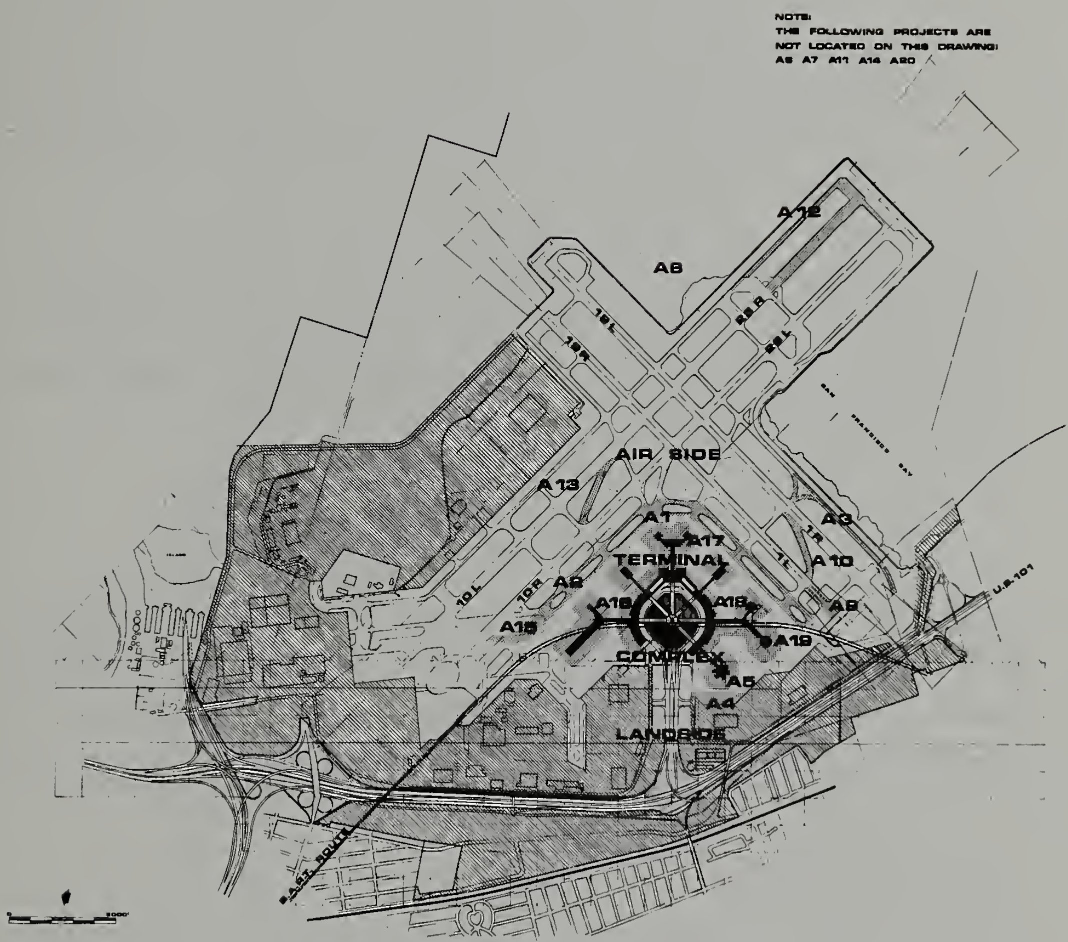


Figure 1-4. Airside Area Projects

- Phase II

A9	Runway 1L Extension	230,000*
A10	Runway 19L — High-Speed Exit	600,000
A11	Runway Drains 19R and 19L	500,000
A12	Runway 28R Extension	2,900,000
A13	Runway 28R — High-Speed Exit	550,000
A14	Runway Drains 28R and 28L	500,000
A15	Extend Taxiways A and B to 10R	1,500,000
A16	North Terminal Aprons	4,000,000
A17	East Terminal Aprons	3,250,000
A18	South Terminal Aprons	1,000,000
A19	Boarding Area B Apron	2,120,000**
A20	Noise Monitoring Program	500,000
		$24,000,000

Generally, the Airside projects included in the revised expansion program were denoted as high priority by Peat, Marwick, and Mitchell's recent study, Analysis of Airfield Improvements at San Francisco International Airport.

Landside Area

Figure 1-5 shows the Landside Area and locates the projects included in the Proposed Expansion Program. These projects provide for facilities needed to support the activities of the airport, and consist of two groups: Landside Facilities and Airport Service Facilities. Specific items are:

Landside Facilities

- Phase I

L1	Cargo Building No. 7	$ 387,000
L2	North Airport Fill	2,464,000
L3	West of Bayshore Fill	1,805,000

* Recommended to be deleted
** Recommended for scope increase to include Air Pollution monitoring

Figure 1-5. Landside Area Projects

- Phase II

L4	West of Bayshore Utilities and Roads	1,300,000
L5	Seaplane Harbor Fill	10,000,000*
L6	Seaplane Harbor Utilities and Roads	2,500,000*
L7	Relocate Standard Oil Hangar	900,000

Airport Service Facilities

- Phase I

L8	West of Bayshore Power Substation	357,000
L9	Sewage Treatment Plant	2,410,000
L10	Influent and Effluent Lines to Sewage Treatment Plant	460,000
L11	Utilities to Sewage Treatment Plant	233,000

- Phase II

L12	Sewage Treatment Plant Standby Power	525,000
L13	Deep Water Outfall	500,000
L14	Replace Present Sanitary Sewers	700,000
L15	Industrial Waste Plant	2,500,000
L16	Industrial Waste Force Mains	1,000,000
L17	Industrial Waste Pump Stations	500,000
L18	Administration Building	5,000,000
L19	Automatic Control System	5,000,000
L20	Airport Maintenance Facility	1,500,000
L21	Fire-Crash Building	500,000
L22	North Access Road	230,000
L23	Widen Frontage Road to Four Lanes	2,500,000**
L24	Overpass to West of Bayshore (Funded by State Highways Department)	–
		$43,271,000

B. DESCRIPTION OF ENVIRONMENTAL SETTING

1. REGIONAL ENVIRONMENTAL SETTING

The regional environmental setting in which the project is located consists of a nine county area surrounding the Bay of San Francisco. Four of these counties border as well on the Pacific Ocean. The 450 square mile San

* Recommended for deferral pending preliminary design of fill and impact report.

** Recommended scope to be changed to indicate improvements to intersections of Frontage Road with Millbrae and San Bruno Avenues.

Francisco Bay lies in a valley between ranges of mountains and opens to the Pacific Ocean through a relatively narrow passage at the Golden Gate. Earthquake fault lines traverse the area on each side of the Bay.

San Francisco Bay is a unique body of water that has many diverse uses. The Bay is used for commercial and recreational purposes such as shipping, fishing and boating, as well as being a breeding ground for several varieties of fish. Shallow waters are immediately east of the Airport. These waters move by tidal action across mud flats and bring water and minerals to plants and fish.

Wild plants and animals abound in the San Francisco Bay region. Over 1,000 different kinds of higher plants and several hundred birds and mammal species are present. If all invertebrates were included, the list of animal species would probably run into the tens of thousands. Animal life in the Bay Area is well diversified. There are many varieties of birds such as pelicans and terns that utilize the Bay. However, because of the long term commercial and industrial activities at and adjacent to the project location, relatively few of these species are observed today near the project site.

The climate of the coastal areas is tempered by winds from the Pacific and these areas usually have cool summers and warm winters. Snow is nearly unknown in most of the nine counties of the Bay Area. Rainfall varies within the Bay Area with San Francisco having an annual rainfall of 22 inches.

In 1970 the population of the area was approximately 4.6 million people, residing in the various counties as shown below:

County	Population
Alameda	1,073,184
Contra Costa	555,805
Marin	206,758
San Francisco	715,674
San Mateo	556,601
Santa Clara	1,066,421
Napa	79,140
Solano	171,815
Sonoma	204,855
Total	4,630,283

San Francisco and Oakland are major West Coast ports serving traffic throughout the Pacific Ocean area. The metropolitan areas of San Francisco, Oakland and San Jose are manufacturing centers and San Francisco is the financial center of the West Coast. Much of the nine counties is devoted to agriculture and dairy farming. San Mateo County has a thriving business in cut flowers while Napa County is famous for its vineyards.

The area is served by major north-south and east-west freeways. Southern Pacific Railroad serves the San Francisco Peninsula with commuter trains and freight trains. A new rapid transit system will serve a portion of the Bay Area local traffic.

Three commercial airports serve the Bay Area-San Francisco International (SFO), Oakland (OAK) and San Jose (SJC). The majority of the air traffic flies from the San Francisco airport; in 1972 SFO handled 15,500,000 passengers, OAK 2,080,000 and SJC 1,886,000. There are 11 key general aviation airfields in the area and 4 military or naval air facilities.

In 1970, aviation aircraft in the Bay Area emitted 138 tons of pollutants per day. This compares with 9,463 tons per day from all sources in the nine-county Area. The state standards for air quality in the Bay Area in 1970 were exceeded, the number of days or times shown in the table below.

Table 1-1

AIR QUALITY DATA — BAY AREA,* 1970

Substance	State Standard	Number of Times Standard Was Exceeded
Oxidant	0.1 ppm for 1 hour	106 days
Carbon Monoxide	10 ppm for 12 hours	5 days Highest 12-hour average: 11.8 ppm
Sulfur Dioxide	0.04 ppm average for 24 hours	18 days
	0.5 ppm for 1 hour	Approximately 16 days of concentration above 0.5 ppm for 60-minute periods or longer. (1969 data)
Particulate Matter	60 $\mu g/m^3$ annual geometric mean	Range: 51 $\mu g/m^3$-73 $\mu g/m^3$
	No single 24-hour sample to exceed 100 $\mu g/m^3$	Approximately 15% of 24-hour samples were greater than 100 $\mu g/m^3$
Visibility-Reducing Particles	Visibility of not less than 10 miles when relative humidity is less than 70%	130 days in San Francisco 113 days in San Jose 163 days in Moffett Field
Nitrogen Dioxide	0.25 ppm for 1 hour	9 days

*Data is for January-November, 1970, six counties only: Alameda, Contra Costa, Marin, San Francisco, San Mateo and Santa Clara.

2. LOCAL ENVIRONMENTAL SETTING

The water of the San Francisco Bay and the rail lines of the Southern Pacific Railroad geographically isolate the airport from the surrounding suburban areas. The land environment in the vicinity of the project is a typical one surrounding a major airport that has been in existence over a long period of time. When the Airport first began operations at this site in 1927 it was in a relatively isolated area. Now, over 45 years later, San Francisco International Airport has become the major commercial airport in the Bay Area.

As the Airport grew, so did the surrounding communities, and now the land areas adjacent to the Airport are dense urban developments. Immediately north and south of the Airport there are many airport related commercial and light industrial facilities, including hotels, motels, rental car facilities, flight kitchens and park-and-fly facilities. As shown on Figure 1-1, the Airport is partially surrounded by the San Francisco Bay, has a major North-South freeway crossing its western portion, has the Southern Pacific Railroad along part of its western bounday, and has suburban residential and commercial areas on its west, south and southeast sides.

The Bayshore Freeway, which crosses the airport property, was built as the main North-South traffic route along the San Francisco Peninsula. The bulk of the traffic on the freeway is attributable to the suburban area traffic and the daily commuter traffic between San Francisco and Peninsula cities.

The environment in the vicinity of the project is governed by its proximity to a very large bay, an existing major airport activity, a heavily travelled freeway, a main line railroad, and extensive commercial and light industrial development.

The Airport itself is built on a man-made fill varying in thickness from 6 to 21 feet. This fill is supported on soft Bay mud varying in thickness from 19 feet to 60 feet. Bedrock, overlain by various sand and clay deposits, is at depths varying from 62 to 152 feet below the existing ground surface.

Topography creates unique weather conditions near San Francisco Airport. The San Bruno and the coastal range west of the Airport block out the wind blowing directly off the ocean. These mountains create a funnel effect so that the ocean breezes that do pass over the mountain range provide a fairly constant wind direction. The Airport is located in an area where the air quality is classified by the Bay Area Air Pollution Control District as transitional between light air pollution potential (some contaminants will be occasionally exceeded) and moderate air pollution potential (all contaminants will be occasionally exceeded).

The land areas on the south and west sides of the Airport are considerably affected by the noise created by existing aircraft operations. Noise affected areas extend from the Airport to the Pacific Ocean under the take-off flight path from the runways heading 280°. Additionally, the Millbrae and Burlingame areas are affected by take-off and landing noise from runways 1-L and 1-R. Foster City is affected by noise from aircraft landing on runways 28-L and 28-R. These noise impact areas have been identified in the San Mateo County Interim Land Use Plan and appropriate uses of these areas are set forth.

The following communities are in the vicinity of the Airport:

Community	1970 Population
Brisbane	3,003
Burlingame	27,320
Daly City	66,922
Foster City	9,522
Hillsborough	8,753
Millbrae	20,920
San Bruno	36,254
San Mateo	78,991
South San Francisco	46,646

As indicated above, San Francisco International Airport is a major existing airport in a large urban area and serves a major air transportation demand.

3. RELATED PROJECTS

Related projects that are either planned or under construction in the area include:

1. Completion of Interstate 380 to the Airport
2. Expansion of Oakland and San Jose Airports

The completion of Interstate 380 to the airport will divert some of the airport vehicular traffic from Highway 101 to Route 280 and temporarily relieve congestion on that highway. It will also reduce the traffic on San Bruno Ave to the point where in 1985 it will be only a third of its present traffic, and will prevent an increase of traffic through 1985 on Millbrae Ave.

The Oakland Airport is expected to expand to accommodate 24,000,000 annual passengers and San Jose is expected to accommodate 10,000,000 annual passengers. These expansions are in accord with the RASS recommendations to provide sufficient facilities at existing airports to meet the needs of the travelling public. Their extensive studies indicated this course of action would result in the greatest advantages with fewest adverse impacts.

A possible development is the extension of the Bay Area Rapid Transit (BART) system from the Daly City station direct to the Airport and down the San Francisco Peninsula towards San Jose. Such a development would reduce automobile airport traffic as well as commute traffic along Highway 101. From the experience along the present BART routes it would also induce growth near its stations unless there were effective restraints by the appropriate governing bodies.

SECTION TWO

Section 2

ENVIRONMENTAL IMPACT

The expansion program involves a considerable number of projects. Each project by itself may have relatively little impact, but the combined total of projects into a complete system will have a measurable overall impact. These projects can be viewed as synergistic; the total system impact is greater than the sum of each individual project's impact.

A brief paragraph description of each project together with a paragraph summary of the environmental impact of each individual project is given in Appendix A.

Positive impacts of the airport expansion include the following:

- Terminal facilities will be increased to accommodate the projected number of passengers which will reduce congestion.
- Roads and parking facilities will be increased to accommodate the increased number of passengers and reduce traffic congestion.
- The many building facilities are under the architectural review and control of one firm so that the total development will be one architectural and visual whole.
- The expanded facilities will allow more of the larger and quieter aircraft to use San Francisco International Airport.
- The use of large aircraft will require greater spacing between aircraft before landing or after takeoff because of air turbulence and will probably limit the airport to 310,000 annual airline operations. The use of the larger and quieter aircraft together with the limit on operations should reduce projected noise below 1972 levels.

- The air pollutants produced by aircraft are expected to be less in 1985 as compared with 1972 due to the limit of aircraft operations and the conversion to newer, more efficient engines developed to reduce emissions.
- Provision is being made in the expansion program for a Bay Area Rapid Transit (BART) station. If BART is extended to the Airport, it is expected to reduce the dependence of air passengers on the automobile and hence reduce air pollution.
- The quality of water entering San Francisco Bay from the Airport will be improved in 1985 over 1972 because an industrial wastewater treatment plant and a deep water outfall sewer line are being provided.
- The extension of Runway 28R should reduce noise levels for surrounding communities.

The adverse impacts of the expansion program include the following:

- *Extension of Runway 1-L will increase noise impact on areas of Millbrae and Burlingame.
- More water, gas, electrical power, and aviation fuel consumption will be a secondary result.
- More vehicle traffic will be experienced.
- The construction and remodeling will cause some minor interferences with vehicle traffic and passenger movements.
- **Some fill in the Bay may be accomplished at the Seaplane Harbor.

A. Is the Development Controversial?

Historically, projects of this magnitude are found objectionable to some portion of the population and therefore are controversial. The proposed San Francisco International Airport development program has some opposition on the grounds of growth inducement, increased ground traffic,

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*This project recommended for deletion
**This project recommended for deferral pending further study

and utilization of natural resources. However, the program is in conformance with the Regional Airport Systems Study and the Airport Element of the Bay Area Regional Plan 1970-1990 prepared by the Association of Bay Area Governments.

The estimated cost of this program is over $390 million. Several groups or individuals suggest that this money should be spent in other areas for the betterment of society. However, this money will be made available mainly through the sale of revenue bonds and the entire amount will be paid for by the users of the airport; hence, the money would not be available for other purposes.

Public hearings and letters received on the Regional Airport Systems Study (RASS) indicate the following classes of comments:

- No airport expansion in the Bay Region is favored. Increased passengers would be accommodated by higher load factors on aircraft, revised flight schedules, or alternate means of transportation.
- Any filling of the Bay for airport expansion was opposed by some people for aesthetic reasons.
- It was alleged that only a small percentage of the population are airplane passengers
- Some comments were received from people who indicated that they would be willing to choose reduced service for environmental reasons.

A summary of the RASS public hearings is contained in Appendix B.

The three public hearings on the expansion program indicated opposition to the airport expansion because of the following main allegations:

- Growth
- Noise impact

- Ground traffic
- Air and water pollution
- Bay fill
- Consumption of natural resources

The summaries of the public hearings on the Expansion Program are in Volume II and the transcripts of the hearings are in Volume III.

B. Will the Development Noticeably Affect Ambient Noise Levels for a Significant Number of People?

Noise from current operations at San Francisco International Airport is an environmental factor of concern to many citizens. The question of expansion of the facilities, therefore, introduces concern about the changes in noise environment that would accompany the airport expansion. This phase of the environmental impact study is concerned with defining, in as quantitative a manner as possible, the changes in noise environment for the proposed expansion as compared to the current noise exposure.

The expansion program will enable more of the larger and quieter jet aircraft to use San Francisco International Airport. These quieter aircraft, together with a limit being reached on aircraft operations because of spacing requirements due to large jet air turbulence, will mean that the aircraft operations at San Francisco International Airport will be quieter in 1985 than in 1970.

Bolt, Beranek and Newman, in their report(1), described the noise effects in 1970 and those anticipated in 1985. The noise was described by Noise Exposure Forecast (NEF) contours. These contours are prepared mathematically and take into account the type of aircraft, frequency of aircraft

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(1) Bolt, Beranek and Newman, Aviation Noise Evaluations and Projections, San Francisco Bay Region, August 1971

operations, the number of operations using an individual runway, the time of day or night the operation is performed, and the type of engine used on the aircraft. A detailed description of the NEF procedure used is given in Appendix D.

The 1970 and 1985 NEF contours are shown in Figures 2-2 and 2-3, which also indicate land uses related to the contours. Figures 2-4 and 2-5 show schools and hospitals related to the noise contours. Figures 2-6 and 2-7 show parks, recreational areas, and wildlife areas as related to the noise contours. (Figures 2-2 through 2-7 are presented in detachable form in Volume IV).

These noise contours assumed 380,000 annual airline operations. The final RASS report recommended a capacity of 310,000 annual airline operations, so the 1985 contours would shrink somewhat with the lower number of operations. Also, these contours were made before actual noise data were available for the DC-10 and L-1011 aircraft. The first available noise data for the DC-10 indicate that the actual takeoff noise levels at full thrust are substantially less than earlier industry estimates.

New California noise regulations stipulate that, by 1985, noise impacts on residential areas over Community Noise Equivalent Level (CNEL) 65 will not be permitted. (A 65 CNEL is roughly equivalent to a 30 NEF.) The Final Plan of RASS concluded that this noise criteria could be met. A noise monitoring program is being set up for the San Francisco International Airport to assure that the California noise regulations will be complied with. Compliance with the noise regulations will be primarily by aircraft operational procedures, using the more quiet aircraft, phasing out of existing noisy aircraft, and retrofitting some noisy aircraft with quieter engines.

Based on the 30 NEF contours computed for 1985, the noise impact on residential land decreased considerably between 1970 and 1985 as shown in Table 2-1. Since the preparation of these reports, it is anticipated that engine improvements and operational procedures will further reduce the noise impacts until the 30 NEF contours will fall only on airport or industrial property.

Table 2-1

LAND USE WITHIN 30-NEF NOISE CONTOUR LEVEL
FOR SAN FRANCISCO INTERNATIONAL AIRPORT

Land Use	1970	1985[a]
Residential	3,685.	
Acres	3,685.7	2,123.0
Building Count	22,822	12,924
Schools		
Acres	177.9	96.2
Building Count	36	21
Hospitals		
Acres	2.9	0
Building Count	1	0
Commercial		
Acres	2,852.8	1,821.6
Vacant		
Acres	3,130.6	2,002.4
Airport		
Acres	1,855.2	1,588.3
Cemetery		
Acres	373.0	176.5
Total Acres	12,078.1	7,807.9

[a]Assumes no change in land use between 1970 and 1985.

Source: P. Dygert, J. Ungerer, Airport Noise and Land Use, ABAG, March 1972

The airport Expansion Program will provide for the larger and quieter jets. These larger jets, combined with an airport capacity limitation, will mean that less area is affected by noise within the 30 NEF contour in 1985 than occurred in 1970.

C. Will the Development Result in Displacement of a Significant Number of People?

The San Francisco International Airport Expansion Program does not involve the displacement or relocation of people. No taking of residential land is contemplated.

Cities adjacent to the airport are providing legal means to minimize land use outside the airport that may be incompatible with airport use. In the past, individual cities have attempted to evaluate the airport's impact on a city's land use plan. However, the land uses between cities were not coordinated in every case. In 1965, a San Mateo County Regional Planning Committee (RPC) was formed, composed of one city councilman from each community and one planning commissioner from each city in San Mateo County and one County Supervisor and the County Planning Commissioner.

In 1970, the San Mateo County Board of Supervisors designated the RPC as the Airport Land Use Commission. A select committee, the Airport Land Use Committee (ALUC), composed of a portion of the Airport Land Use Commission, was formed to prepare the plan and hold any public hearings as required.

An interim plan was adopted February 28, 1973 to provide guidance to local jurisdictions in evaluating development proposals within airport impacted areas. A final plan will be prepared jointly with the local jurisdictions and the commission will request that the incompatible portions of adopted land use plans be reviewed at public hearings before the ALUC and findings of fact transmitted to the local jurisdiction. The decision is binding unless overruled by 4/5 vote by the governing body of the local jurisdiction.

D. Will the Development Have a Significant Aesthetic or Visual Effect?

The proposed expansion will have a significant aesthetic and visual effect. The Expansion Program, when it is completed, will present a series of structures with clean lines, architecturally integrated so that they will all have a similar appearance. The existing East Terminal will be remodeled so that it will blend in with the new structures to be constructed. Several small and old structures will be demolished and replaced by better looking, more functional buildings. Many of the baggage trains that are now traveling on the apron between airlines will be replaced by an underground interline baggage system. The Bay Area Rapid Transit (BART) system will be in a tunnel under the airport and, when operational, will eliminate the need for a number of surface vehicles. In addition to the many structures to be constructed that contribute to the total visual effect, an item for art enrichment is a part of the Expansion Program.

The Expansion Program is under the architectural and aesthetic control of one firm even though construction plans will be prepared by a number of firms. The main terminal buildings will be three stories high and the boarding areas will be two stories high. The central parking structure will be five levels high for automobile parking and will have a sixth level devoted to a People Mover System. A Federal Aviation Administration control tower nominally 200 feet high will be located in the center of the parking structure.

Some residences in the cities of Hillsborough, Burlingame, Millbrae, San Bruno, and South San Francisco have views of the airport because they are at a higher elevation than the airport. In addition to the residents viewing the airport, millions of air passengers will pass through the airport annually.

Although the Expansion Program doubles the number of square feet of the building space over existing space, the visual effect will be an improvement over existing conditions.

The aesthetic impact on users of the Bay is expected to be improved. From the Bay, the terminal building will appear to be one-third longer, primarily because of the North Terminal. The structures will appear to be cleaner because the existing concourses will be replaced by more modern and efficient structures.

E. Will the Development Divide or Disrupt an Established Community or Divide Existing Uses?

The proposed expansion at San Francisco International Airport will not physically divide or disrupt an established community or divide existing uses. All the expansion is being accomplished within existing airport boundaries.

F. What will be the Effect on Areas of Unique Interest or Scenic Beauty?

The San Francisco International Airport Expansion Program is being accomplished within the existing airport boundaries. Although it is adjacent to the Bay, which is an area of unique interest and scenic beauty, the project will not impinge upon the Bay but will enhance the appearance of the airport to users of the Bay.

G. Will the Development Destroy or Derogate Important Recreational Areas?

Figure 2-6 shows the existing parks near San Francisco International Airport; also shown are the noise contours for 1970. Figure 2-7 shows the parks and expected noise contours for 1985.

The parks include private golf courses, municipal parks in several cities, county parks, proposed county parks, and state parks.

The proposed development will not physically touch any park. A comparison of the 1970 and 1985 NEF contours shows that the 1985 contours are smaller, indicating a lowering of the aircraft noise levels as compared with 1970. This indicates that as the quieter aircraft become predominant, and for approximately the same number of annual operations, the parks and recreational areas will have less aircraft noise and air pollutants.

H. Will the Development Substantially Alter the Pattern of Behavior for a Species?

The expansion program for San Francisco International Airport will not substantially alter the pattern of behavior for a species. The development is being accomplished on the existing airport in areas that are presently utilized for commercial or industrial airport uses.

I. Will the Development Interfere with Important Wildlife Breeding, Nesting or Feeding Grounds?

The proposed Airport Expansion Plan will not interfere with important wildlife breeding, nesting or feeding grounds. The expansion is being accomplished on existing airport property. The water entering the

Bay will be cleaner in 1985 than in 1970 because of improved sewage treatment facilities and waste water treatment facilities. This will enhance the environment for any water life adjacent to the airport.

A clear relationship between wildlife and aircraft noise and operations has not been established. Information is only recently becoming available on the effects of sound on living organisms. One report indicated an increased wheat plant size when the plants were subjected to sound frequencies between 5,000 and 300,000 cycles per second. A detailed description of existing wildlife in the bay area is contained in Appendix G.

An evaluation of the impact of the airport expansion on wildlife cannot be made in a quantitative manner. However, it is shown elsewhere in this environmental impact statement that air pollution is expected to decrease compared to 1970 levels, noise is expected to be less compared to 1970 levels, and waste discharges will be "cleaner" compared to 1970 levels; thus, the 1985 environment will be better than that of 1970.

J. Will the Development Significantly Increase Air or Water Pollution?

1. Air Quality

The air quality in the vicinity of San Francisco Airport is expected to improve by 1985 over 1970 conditions. In February 1971, the Bay Area Pollution Control District produced a report, Aviation Effect on Air Quality. This report described the existing air quality in the Bay Area in 1970 and the expected air quality in 1975, 1980 and 1985. It calculated the amount of emissions expected from aircraft at each airport in the future years, as well as emissions expected from other sources throughout the nine counties of the Bay Area.

The total air emissions are summarized in Table 2-2, which indicates that the SFO-related air contaminant emissions for 1985 will decrease over 1970 levels.

Table 2-2

TOTAL NINE-COUNTY AIR EMISSIONS
(tons per day)

	Nine-County 1970	SFO 1970 Portion	Nine-County 1985	SFO 1985 Portion
Total nine-county (all sources)	9.463	246	3,600	90.6
Aircraft	121	49.7	200	47.9
Other airport	17	13.3	10	4.7
Autos to airports	NA	183.0	80	38.0

The number of automobiles to and from the airport will increase in 1985 as compared with 1970. The emissions from automobiles traveling to or from the airport will go down from an estimated 183 tons per day in 1970 to 38 tons in 1985. This marked reduction is due to more stringent auto pollution devices required of car manufacturers. The 1970 figure was calculated as follows:

Emission	1970 — Grams/Mile
CO (Urban)	95.0
HC (Urban)	14.7
NO_x	6.63
Particulates	0.3
SO_2	0.11

Source: E.P.A., Compilation of Air Pollutant Emission Factors, February, 1972

The emissions are for the average car in 1970. The average passenger's one-way auto trip is 21 miles to the airport, and the average employee's one-way auto trip is 14 miles. In 1970, there were an estimated 50,000 average daily passenger-auto trips to and from the airport, and 27,000 average daily employee-auto trips to and from the airport.

The Bay Area Air Pollution Control District prepared a mathematical model for predicting air pollution at specific points in the Bay Area because of operations at SFO. This model did not show any major differences from present conditions. Their model was based on up to 558,000 annual airport operations, far in excess of the 370,000 annual airport operations now expected to be the total airport capacity.

The 370,000 total runway operations include 310,000 airline operations and 60,000 other aviation-type operations. The annual airport capacity has been reduced because of turbulence caused by large aircraft, resulting in a greater separation between aircraft than occurred in 1970. This means that the expected pollution levels will be less than predicted by the mathematical models. See Appendix E for a more detailed description of air quality.

2. Water Quality

The San Francisco International Airport discharges effluent into the Bay from three sources: a sewage treatment plant, and two systems of combined storm drain and industrial treatment.

The Expansion Program will provide for cleaner water being discharged into the Bay. A sewage treatment plant was recently constructed and an industrial waste treatment plant is provided in the Expansion Program.

These projects, together with some support projects, will treat water more completely than is being done today.

The facilities that are presently used in controlling effluent to State standards consist of the following:

- Sewage. A new 2.2-million-gallon-per-day (average) sewage treatment plant at the North edge of the airport property
- Industrial Waste. Source control by means of separators at the tenants' facilities followed by two oxidation ponds for detention of effluent for 13 days (North Pond) and 7 days (South Pond)

Present water quality requirements are in substantial compliance with State water quality standards. The two exceptions concern toxicity in sewage treatment and toxicity in industrial wastes. The toxicity test requires a stickleback fish to survive in test waters for 96 hours.

Table 2-3 shows a detailed comparison of sewage test results and the corresponding standards. All standards were in substantial compliance for the year except for toxicity. The toxicity test is difficult to perform because the fish may die from causes unrelated to water quality, such as sudden temperature changes, inadequate oxygen during shipment of the fish, etc. The environmental impact statement for the South San Francisco deep water outfall indicated that using a brackish water fish (the stickleback) may be overly conservative for salt waters, since saltwater species seem not to be affected as much by foreign substances as brackish-water fish.

Table 2-3

SAN FRANCISCO INTERNATIONAL AIRPORT
WATER QUALITY CONTROL PLANT
SEWAGE TREATMENT TEST RESULTS
(Sampling Period - August 1971 to September 1972)

Receiving Waters (Bay)						
	Test Results					
Parameter	Minimum	Maximum	Average	Median	State Requirement Resolution No. 70-12	Percentage In Conformance
Dissolved oxygen	5.5	13.5	9.2	9.1	minimum 5.0	100
pH	7.1	8.4	7.8	8.1	7.0 to 8.5	100
Dissolved sulfides	0	0	0	0	maximum 0.1	100

	Number of Days Observed	Number in Violation	Percentage In Conformance
Floating solids	284	0	100
Floating oil	284	0	100
Discoloration	284	0	100
Odor	284	0	100

Waste Stream (Effluent From Plant Before Entering Bay)						
	Test Results					
Parameter	Minimum	Maximum	Average	Median	State Requirement Resolution No. 70-12	Percentage In Conformance
Coliform	2	1,400	99	23		97.5
Toxicity (96-hr survival)						
Undiluted	0	100%	29%	5%	90%	20
TLm	36%	100%	75.6%	76%		
Biochemical oxygen demand removal	72.5%	97.7%	92.5%	95%	90%; or 80% in two consecutive samples	100
Settleable matter (ml/L/1 hr)	0	0.5	0.1	0.1	0.5	100

Source: San Francisco International Airport Engineering Division

Tables 2-4 and 2-5 show detailed comparisons of industrial waste treatment test results and the corresponding standards. Data are shown separately for the North Pond and the South Pond. The results show that in all cases the ponds were in substantial compliance with standards over the 20-month period ending in September 1972.

For both sewage and industrial waste treatment, corrective measures are put into effect when water quality tests, some of which are conducted daily, exceed standards. This includes enforcement of regulations applied to tenants on the airport property.

The Phase II airport expansion program provides for additional effluent control capacity to meet project needs to 1985. The elements of the development program that concern effluent treatment are:

- Construction of an industrial waste plant
- Deep water sanitary outfall to one mile offshore
- Industrial waste force mains from oxidation ponds to the industrial waste plant
- Expansion of sewage treatment plant
- Industrial waste-pumping stations
- Replacement of existing sanitary sewers (to increase capacity and operating pressure)
- Stand-by power station for the 2.2 mgd sewage plant

The bases for developing these expanded water quality control facilities were:

- A projection of additional wastewater by type and constituent characteristics brought about by the general Phase II expansion program
- A forecast of water quality standards applicable to the projected period

Table 2-4

SAN FRANCISCO INTERNATIONAL AIRPORT
DRAINAGE STATION NO. 1 — SOUTH OXIDATION POND
INDUSTRIAL WASTE TREATMENT TEST RESULTS
(Sampling Period — Monthly, January 1971 to September 1972)

Parameter	Units	Test Results				State Requirement Resolution No. 692[a]	Percentage In Conformance
		Minimum	Maximum	Average	Median		
Grease	mg/L	5.7	26.0	12.9	11.0	20	95
Phenols	mg/L	0.02	0.76	0.19	0.08	0.50	89
Cyanide	mg/L	<0.06	<0.06	<0.06	<0.06	1.0	100
Cadmium	mg/L	0.02	0.20	0.04	0.02	1.0	100
Total Chromium	mg/L	0.02	0.06	0.03	0.02	2.0	100
Copper	mg/L	0.02	0.05	0.03	0.02	0.26	100
Lead	mg/L	0.02	0.17	0.04	0.03	0.10	95
Nickel	mg/L	0.02	0.08	0.03	0.02	Not specified	100
Silver	mg/L	0.02	0.05	0.03	0.02	1.0	100
Zinc	mg/L	0.02	1.0	0.19	0.07	1.0	100
pH	mg/L	6.8	10.2	7.9	7.8	6.5 to 8.5	85
Settleable Solids	ml/L/1 hr	0.0	0.2	0.1	0.1	0.5	100
Bio-Assay (% survival in 96 hr)		0	100	66	90	90	67

[a]Resolution 692, California Regional Water Pollution Control Board No. 2, San Francisco Bay Region, August 19, 1965.

Source: San Francisco International Airport Engineering Division

Table 2-5

SAN FRANCISCO INTERNATIONAL AIRPORT
DRAINAGE STATION NO. 2 — NORTH OXIDATION POND
INDUSTRIAL WASTE TREATMENT TEST RESULTS
(Sampling Period — Monthly, January 1971 to September 1972)

Parameter	Units	Test Results				State Requirement Resolution No. 692	Percentage In Conformance
		Minimum	Maximum	Average	Median		
Grease	mg/L	3.9	18	10.1	9.0	20	100
Phenols	mg/L	0.01	0.75	0.18	0.12	0.50	94.75
Cyanide	mg/L	0.06	0.12	0.06	0.06	1.0	100
Cadmium	mg/L	0.02	0.19	0.05	0.03	1.0	100
Total Chromium	mg/L	0.02	0.48	0.09	0.08	2.0	100
Copper	mg/L	0.02	0.13	0.03	0.03	0.26	100
Lead	mg/L	0.02	0.15	0.05	0.03	0.10	85
Nickel	mg/L	0.06	0.28	0.11	0.10	Not specified	100
Silver	mg/L	0.02	0.07	0.03	0.02	1.0	100
Zinc	mg/L	0.02	1.0	0.19	0.09	1.0	100
pH	mg/L	6.9	8.4	7.9	8.0	6.5 to 8.5	100
Settleable Solids (ml/L/1 hr)		0.0	0.1	0.1	0.1	0.5	100
Bio-Assay (% survival in 96 hr)		0	100	92	99	90 Min.	89.5

Source: San Francisco International Airport, Engineering Division

The forecast of future water quality standards applicable to the airport was based on Interim Water Quality Control Plan for the San Francisco Basin, California Regional Water Quality Control Board, June 1971. The policy guidelines and objectives contained in this basic reference are recognized as being imprecise and subject to quantitative definition. However, to provide a basis for Phase II expansion requirements, the firm of Metcalf and Eddy, Palo Alto, was retained by the airport to assist in forecasting what the water quality standards would be and to relate these projected standards to facility requirements. The additional effluent control facilities shown in the Phase II plan are the result of this study.

Since the development of the effluent facility plan for Phase II, the Federal Government enacted the Federal Water Quality Control Act of 1972. Future standards for water quality in the airport region are now uncertain. Title III of the Act applicable to the airport provides that point sources "shall require application of the best practicable control technology currently available as defined by the Administrator." And by July 1, 1983, Title III requires effluent limitation for categories and classifications of point sources that "shall require application of the best available technology economically achievable...which will result in reasonable further progress toward the national goal of the elimination of all pollutants."

The Act requires local cognizant authorities to submit standards and implementation plans to achieve the goal set out in the Act. These local water quality requirements have yet to be developed for public hearings and enactment. The outlook, however, is for progressively more stringent standards from the present through 1985.

Since the State of California has already moved aggressively in the field of water quality management, the impact of the Act on present standards and the timetable for new standards may not prove to be substantial. Considerable study was involved in preparing the Interim Water Quality Control Plan for the San Francisco Bay Basin.

In summary, the present effluent treatment facilities are in substantial compliance with State requirements for water quality, with special control procedures needed from time to time to meet exceptions.

The sewage and industrial waste facilities under the Phase II expansion were designed to meet presently forecast requirements of the cognizant State Water Quality Control Board. However, the impact of the Federal Water Quality Control Act of 1972 is yet to be determined and Phase II water treatment facilities and control procedures may require further augmentation to meet evolving new and more stringent standards brought about by this Act.

Pollution effects caused by aircraft at the ends of the runways are not expected to change because of the airport expansion. The runways, except for the paving of the extension of 28R, are to remain the same. The number of aircraft operations is to remain at nearly the same level as 1970.

K. Will Development Adversely Affect the Water Table of an Area?

The water table in the airport area is approximately 5 feet above sea level in wet winter months and drops several feet during the dry summer months. The exact amount of drop during summer months has not yet been accurately determined. The water table is above mean sea level for the following reasons:[2]

- The fill which is superimposed upon the Upper Bay mud tends to increase the pore water pressure in the mud by virtue of its weight, so that the water is forced to flow in all directions including upwards.

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[2] Lee and Praszker, Soil and Foundations Exploration, Proposed Expansion of San Francisco International Airport, April 18, 1969

- The groundwater emanating from the hills to the west travels toward the Bay and it also courses between the interface of the fill and mud. The hydrostatic pressure which causes the water to flow forward also forces it to build up a head in the fill above the mud.

Numerous past and ongoing airport construction projects have indicated that construction affects the water table very little. For instance, the soil in the North terminal foundation excavation is relatively impermeable. The amount of water entering the foundation excavation was extremely small. The drawdown effect of the seepage into the excavation, although not measured, could not have been great even in the vicinity of the excavation, and would not have been discernible at any location off of the airport. Since the North Terminal foundation required as large an excavation as any of the facilities will require in the entire Expansion Program, the effect of the excavation on lowering the water table is expected to be negligible.

All of the foundations of the facilities being constructed are to be waterproofed so that the water table can assume its normal position after construction has been completed.

Groundwater will not be pumped for daily water supply purposes. Water for domestic use or fire-fighting purposes is obtained from the Crystal Springs Reservoir.

L. Employment Impact

The proposed expansion, together with more passengers, will increase the number of employees working on or immediately adjacent to the airport. Basic employees are expected to increase by 13,655 people between 1965 and 1985. These increases will be in the Air Transportation, Hotel,

and Federal Government categories. In 1965, there were 15,530 people in these categories employed on or adjacent to the airport.

For these increases in employment, it is expected that all of the usable vacant land existing in 1965 adjacent to the airport will be in use by 1985.

See Appendix F for a more detailed discussion of this subject.

M. Utility Services Changes

1. Water

The total airport utilized 1.95 million gallons of water per day in 1968-1969. This figure is expected to increase to 5 million gallons of water per day with a peak day demand of 7.5 million gallons. The 5 million gallons is disposed of through a 2,200,000-gallon sewage treatment plant, and a 2,500,000-gallon industrial waste treatment plant with domestic consumption, irrigation, and losses making up the rest of the 5 million gallons consumption. The airport utilized 2.4 percent of the total demand of 82.5 million gallons of water used per day by San Mateo County in 1970. The airport water demand is expected to be 4.7 percent of the County of San Mateo's total water demand in 1985.

2. Sewage

The airport has a separate system for handling sewage. Industrial wastes and storm water flows are a separate system. The airport completed a new 2.2-million-gallons-per-day sewage treatment plant in March 1972, including the necessary influent and effluent lines and utility connections. A deep-water sanitary outfall is budgeted to provide a more effective means to comply with federal water quality standards. The airport has a daily monitoring system to report effluent quality and ensure that the effluent meets water quality standards.

3. Industrial Waste Disposal

The airport generates industrial liquid wastes from airplane cleaning maintenance operations and from motor vehicles. These operations are at many separate locations on the airport. The United Air Lines maintenance base is a major industrial liquid waste contributor. United pretreats its waste before draining it to the airport storm drain system. Occasional fuel spills also contribute. The industrial wastes discharge into the storm drain system. During dry weather the industrial waste flow drains to two oxidation ponds for treatment prior to being pumped into San Francisco Bay. During wet weather, the industrial wastes are diluted with storm water and flow directly into the Bay. The industrial wastes effluent is sampled each month and results are reported to the Water Quality Control Board. The airport currently uses 1,400,000 gallons of water per day for industrial waste treatment.

The Expansion Program includes budget items for an industrial waste treatment plant, force mains, and pump stations. The plant will treat industrial wastewater and will be designed to produce an effluent that meets future standards of the Water Quality Control Board. The net effect will be to provide an improvement by 1985 over existing conditions. The airport is required by law to meet whatever water quality standards are set by the Water Quality Control Board. The water quality standards for 1985 have not been completely defined to date.

4. Storm Drains

The drainage system at San Francisco International Airport removes stormwater from runways, taxiways, and other paved and roofed areas and limits storm water flooding in unpaved areas. The drainage system is a series of pipelines and canals that carry the storm water to the Bay. Most of the system drains to the two detention basins described in the industrial waste disposal system. A small part of the system near

the ends of runways 19 and 28 drains directly into the Bay. The expansion program envisions some additions to the drainage system by a series of pumps and related facilities to enable the system to operate better at high tides. The storm drain water will discharge into the bay at the same point as it now does, but it will be able to do so at all tides, instead of just at low tides. At higher tides more volume of bay water is available to dilute the storm drain water. This will be an improvement over existing conditions. Paving of present unpaved areas will result in some of the storm water reaching the Bay faster. Unpaved areas allow the water to seep into the ground and travel slowly to the Bay. The total effect is to change the time when storm water enters the Bay, but not the amount.

5. Natural Gas

Natural gas is distributed to San Francisco International Airport by the Pacific Gas and Electric Company (PG&E). The average winter gas use in 1969 was 500,000 cubic feet per hour. The 1985 demand is expected to be approximately 1,300,000 cubic feet per hour. Existing supply lines to the airport can supply the increased rates.

6. Aviation Fuel

The number of annual airline operations is expected to decline slightly from 333,000 in 1969-1970 to 310,000 operations in 1985. This reduction is due to the larger separation between aircraft required because of air turbulence created by large jets. This lesser number of aircraft will require more aviation fuel because of the larger average size of aircraft in 1985. The demand in 1970 was 670 million gallons of fuel per year. This is expected to increase to 1,573 million gallons per year by 1985.

Aviation fuel is delivered to the airport now either by underground fuel lines or by barge to a dock on the north side of the airport. The fuel is held in storage areas and then pumped by underground fuel lines to fuel hydrants at aircraft parking positions. The barging operation is an interim procedure that is used now because of slide damage to one fuel line in Oakland. When the fuel line is repaired, the barging of fuel will become an emergency only procedure. The filling of the seaplane harbor will require relocation of the existing fueling dock.

7. Solid Waste Disposal

Solid wastes are generated at San Francisco International Airport. The characteristics of weight and composition for the four major sources on the airport are:[3]

	Weight (tons per week)	Primary composition type
Passenger terminals	68.7	70 percent paper
Air freight area	29.8	46 percent paper 17 percent wood 10 percent plastics
Aircraft service centers	133.2	34 percent food 32 percent paper 12 percent metal 10 percent plastics
United Air Lines aircraft maintenance base	55.6	51 percent paper 15 percent food 10 percent plastics
Total	287.3	

3 Metcalf and Eddy, Analysis of Airport Solid Wastes and Collection Systems, San Francisco International Airport, March 1972

Demolition material, normally generated in large quantities at an airport complex, was not generated during the sampling period and therefore could not be measured.

The unit generation values derived for each source are:

Passenger terminals	0.53 pound per passenger
Air freight area	7.10 pounds per ton of cargo
Aircraft service centers:	
Composite of all activities	1.02 pounds per passenger
Aircraft flights including meal service wastes	2.51 pounds per passenger
Aircraft flights excluding meal service wastes	0.54 pound per passenger
Aircraft maintenance base	2.19 pounds per employee per day

The major solid-waste generator is the aircraft service center, which includes both hangar wastes and aircraft passenger wastes. The most significant waste is from aircraft flights serving meals.

The total quantity of refuse generated at San Francisco International Airport is 287 tons per week. This quantity is projected to increase to 500 tons per week by 1985.

Existing solid-waste systems are controlled individually by each airport tenant, except in the terminals where the airport authority controls the system. A single hauler serves all tenants on the airport. The hauler removes all wastes from the airport for disposal at a county sanitary landfill located about 15 miles from the complex.

Demolition material is hauled in debris boxes or standard earthwork construction vehicles (dump trucks). Wood wastes, normally placed in debris boxes, are disposed of off the airport at the sanitary landfill. Dirt, broken concrete, and broken asphalt pavement are disposed of on the airport in areas where the existing land has subsided and benefits from filling.

Solid wastes from the airport and most other areas of San Mateo County are disposed of at the Menlo Park sanitary landfill. San Mateo County, in conjunction with the City of Menlo Park, estimates that the Menlo Park sanitary landfill site will last for seven to ten years, at which time it will be turned into a park. There are other existing sites in San Mateo County which could be used, such as the one at Half Moon Bay, as well as several potential ones. A definitive plan for the development of another site, after the Menlo Park site is filled, has not been prepared by San Mateo County or the City of Menlo Park.

A mitigating measure is that compactors for solid waste are being put in the new facilities. This will reduce the bulk volume of the material being deposited in a sanitary landfill and will reduce the number of trucks required to carry away the material from the airport.

8. Electrical Load

The airport is located adjacent to the Pacific Gas and Electric transmission corridor that serves four 115-kv transmission lines. The airport is served by three 12-kv feeders from two different substations. All three feeders serving the airport are "clean" with no other loads connected. From a system reliability standpoint, the PG&E system in the San Francisco area is considered to be on par with other major systems in the United States.

Total airport electrical load (excluding the United Air Lines Maintenance Base) in 1971 was 18.0 million volt amperes (mva). This is expected to increase to 62.8 mva by 1978 and is ultimately expected to grow to 90.0 mva. This will be 15 percent of the expected 1985 useage of San Mateo County.

The existing PG&E substations have an ultimate capacity of 90.0 mva when all the necessary equipment is installed. PG&E has demonstrated their belief that they can supply the power by constructing the substation.

The ultimate connected load will be five times the 1971 connected load.

N. GROUND TRANSPORTATION TO SAN FRANCISCO INTERNATIONAL AIRPORT

1. External Access

San Francisco International Airport is on the east side of the San Francisco peninsula, some 15 miles south of the city's central business district. It is in San Mateo County near the cities of San Bruno and Milbrae. Its location in relationship to access facilities is shown in Figure 2-1.

The principal existing approach route from the north or south is the Bayshore Freeway (U.S. 101). A directional-type interchange gives exclusive access to the airport, whose main terminal is one-half mile east of the freeway. U.S. 101 is convenient to all major population centers on the San Francisco peninsula, but due to increasing pressure of other traffic will not give a high level of service to the airport indefinitely.

By 1978, Interstate Route 380 (I-380) will be completed between Interstate 280 and the airport. This will provide a second freeway route to the airport.

Figure 2-1. Regional Access Plan,
San Francisco International Airport

There are also secondary external links to the airport. San Bruno Avenue interchanges with Bayshore Freeway about 1.5 miles north of the main airport access road, and provides a crossing that links to Airport Boulevard north of the main terminal area. These two roads provide direct access to the United Airlines Maintenance Base, and allow indirect access to the passenger terminal area via the frontage road along Bayshore Freeway. Millbrae Avenue and Bayshore Highway both interchange with Bayshore Freeway south of the airport; they intersect just east of the freeway and also allow indirect access to the terminal area via the freeway frontage road.

Although there is a Southern Pacific Company rail line which serves commuters along the Peninsula, it does not serve the airport effectively since there is no service to the airport, even though it adjoins the West boundary of the airport.

The State Division of Highways in April 1973, made a study of the external access to the airport after the I-380 route is finished. The study included traffic on major routes with and without the increase in airport passengers predicted for 1985.

The results of this study are:

- Vehicle traffic is above capacity now at peak hour on 101 south of Millbrae Avenue and north of Airport Boulevard and congestion will increase in 1985. The extent of the demand above capacity is described in Volume III.
- Because 101 will be over peak hour capacity, drivers will be forced to either wait in traffic, divert to other access routes or adjust their trip time. There is sufficient capacity throughout the day to service the airport if people are willing to schedule their trips at times other than peak hour.

- The portion of the freeway between Airport Boulevard and Millbrae Avenue will have capacity to accommodate all expected traffic without congestion.
- Slight congestion will occur at peak hour on the 380/280 Interchange in 1985. The increased airport traffic is a minor contribution to this slight congestion.
- Slight congestion will occur in 1985 on I-280 north and south of I-380. The increased airport traffic is a minor contributor to this slight congestion.
- Vehicular traffic on Millbrae Avenue at 101 is not expected to increase in 1985 over 1970.
- Vehicular traffic on San Bruno Avenue over 101 is expected to drop significantly from 36,000 Average Daily Traffic (ADT) to 11,000 ADT.
- Traffic on El Camino Real south of Millbrae Avenue will not be affected by the airport expansion.
- Traffic on El Camino Real near I-380 will experience increases in local traffic but any impact due to airport expansion will be minimal.

The traffic demands predicted by the State are based on the following assumptions:

1. The 1990 population for San Mateo County is 677,000 compared with 556,000 in 1970
2. A doubling of passengers means a doubling of vehicular traffic to and from the airport
3. No increase in transit facilities
4. No major change in timing of airport operations
5. Peaks on each road occur at the same time

These assumptions present the worst case. Any improvement in transit facilities, changing in timing of airport operations or peaks not occuring at the same time will tend to lower the airport peak hour demand figures calculated by the State.

To mitigate the congestion on 101, there are the following courses of action or combinations thereof:

1. Do nothing
2. Increase roadway capacity
3. Meter freeway on-ramp traffic
4. Provide alternate modes of transportation
5. Off site parking
6. Reschedule airline operations

The airport can encourage alternate modes of transportation such as bus or BART, can encourage rescheduling of airline operations, and can encourage off-site parking.

The complete text of the State Division of Highways study is in Volume III.

2. Internal Parking and Access

The public parking available at San Francisco International Airport in 1972 and the projected parking in 1975 are listed below.

	Number of Spaces	
	1972	1975
Airport Garage	3,110	7,300
Parking Lot No. 1	630	—
Parking Lot B	569	—
Remote Parking	910	1,410
Total	5,219	8,710

Current plans, while in a state of flux, indicate that by 1975 the garage will be expanded to a capacity of 7,300 spaces and will incorporate Lot No. 1. The total public parking will then be 8,710 spaces, if some of this space is not lost either to rental car storage or a transit terminal. Other available airport parking is as follows:

	Number of Spaces
Employee Parking	
Near Pam Am Hangar	870
Near TWA Hangar	350
Near United Hangars	900
Large North Lot (general)	700
Large South Lot (general)	240
Near Present Cargo Buildings	600
Near Pacific Hangar	150
Near Post Office Facility	200
Near American Hangar	150
Near United Maintenance Base	3,000
Near Coast Guard Station	100
	(+500 not in use)
Total	7,760 spaces
Rental Car Storage	300
Official Cars and Other	
(large lots west of Bank of America)	230
Grand Total	17,000 spaces

(In addition, 400 spaces for the Hilton Inn patrons and employees and approximately 200 truck-loading docks exist at the airport. A remote, privately operated parking lot north of the airport with shuttle bus service to the airport terminal began operating in 1970, and a similar one south of the airport began operating in 1971.)

The main access road makes a large loop around the parking structure, its outer perimeter skirting the two passenger terminal buildings, as shown in Figure 2-8. The loop is separated into two roadways at different levels, the upper one at the level of enplaning terminal operations and the lower one at the level where deplaning passengers collect their baggage. This loop is being expanded to skirt the North Terminal, the roadways widened and closures to the loop provided at both levels.

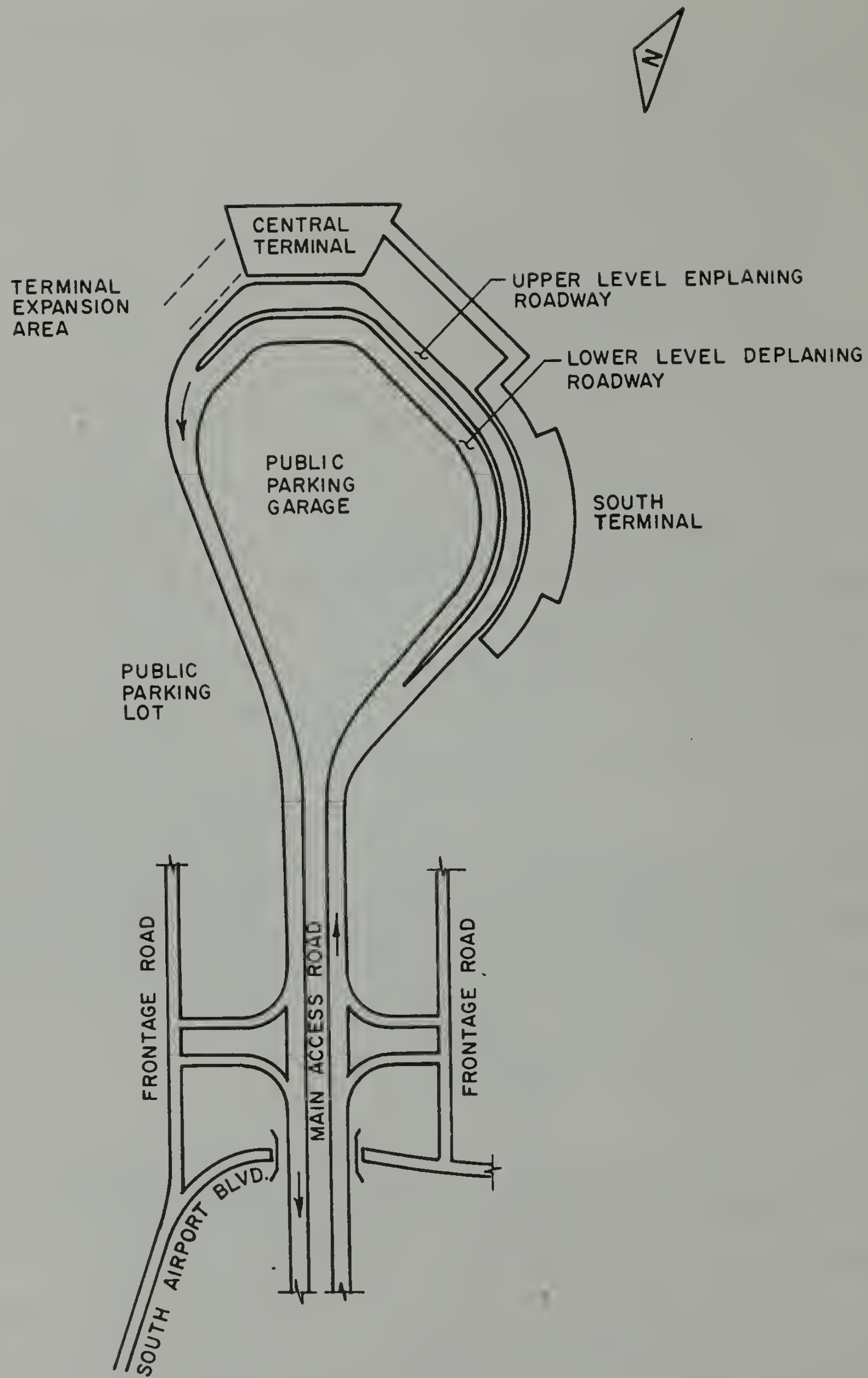

Figure 2-8. Airport Terminal Layout, San Francisco International Airport

The layout does not encourage drivers to perform a curb dropoff and then park in the structure. The minimum distance from the loading curb to the garage entrance is about one-half mile, and it is necessary to weave across three traffic streams entering the circulation loop road from the left before making the required left turn at a grade intersection.

The curb space available for passenger pickup and setdown (measured in linear feet) is as follows:

	Enplaning	Deplaning
Total at South Terminal	800	800
Total at Central Terminal	800	800
Total linear feet of curb space for auto passenger pickup and setdown	1,600	1,600

Due to the random fluctuations in stopping times and in airline demand, observations suggest that 70-percent utilization can be considered as practical capacity. (It is usually desirable to utilize curb frontage that is convenient to the processing centers of the various airline companies.) Present hourly capacity is thus 66,500 foot-minutes for enplaning passengers and 66,500 foot-minutes for deplaning passengers.

Average stopping times vary with the type of vehicle. For the purposes of determining a capacity in terms of vehicles per hour, an assumption must be made as to the percentage of private automobiles, taxis, hotel limousines, and buses. Table 2-6 summarizes the capacities.

The new North Terminal, which will add 800 linear feet of usable curb space to both the enplaning and deplaning roadways. Eventually, the two plaza areas between the three terminals will be enclosed so that a continuous structure will be formed. The usable curb space will then be approximately 3,200 linear feet for each of the roadways.

Table 2-6

1968 HOURLY CURB CAPACITIES FOR ENPLANING AND DEPLANING PASSENGERS – SAN FRANCISCO INTERNATIONAL AIRPORT

Type of Vehicle	Ft-Min Available	Avg. Ft-Min Per Vehicle	Allowable No. Of Vehicles Per Hour	Avg. Air Pass. Per Vehicle	Enplaning Air Pass. Per Hour
Enplaning					
Auto	45,600	50	912	1.3	1,186
Taxi	8,200	30	273	1.7	464
Hotel Limousine	5,500	105	52[a]	2.0[a]	104
Bus	7,200	110	65[a]	8.0[a]	520
	66,500				2,274[b]
Deplaning					
Auto	43,800	75	584	1.3	759
Taxi	8,800	50	176	1.7	299
Hotel Limousine	4,700	140	33[a]	2.0[a]	66
Bus	9,200	220	42[a]	12.0[a]	504
	66,500				1,628[b]

[a] Limousines and buses normally make two or three stops on the terminal roadways at SFO. The number of air passengers per vehicle is therefore the average number disembarking at each stop. Each stop made is counted as a separate vehicle for computational purposes.

[b] The airport capacity is more than these figures because many autos never use curb space, but use only the parking lots or auto rental areas.

If the curb usage characteristics will remain essentially constant, the projected peak hour passenger discharge and pickup capacity of the curb space will increase from the current 3,900 to 7,800 passengers in 1985, as follows:

	1968	1975	1985
Enplaning curb space (feet)	1,600	2,400	3,200
Peak-hour enplaning passenger capacity	2,275	3,400	4,550
Deplaning curb space (feet)	1,600	2,400	3,200
Peak-hour deplaning passenger capacity	1,625	2,450	3,250
Total peak-hour passenger capacity[a]	3,900	5,850	7,800

[a] In this case, "passengers" means the maximum practical number of air passengers utilizing vehicles at the curb frontage for access to and from the terminals. It does not include those using other means of access, such as the parking garage, car rentals, etc.

These figures indicate that curb space for air passengers will double. Potential curb space users will increase by 83 percent by 1985, indicating that the curbs will not be as heavily used in 1985 as in 1970. This is attributed to approximately 30 percent of the airline passengers' using buses and/or rapid transit (BART) in 1985 as opposed to 15 percent using bus transit in 1968.

3. Rapid Transit

A report entitled Route Location, Airport and Approach, San Francisco Airport Access Project by Parsons, Brinkerhoff, Tudor, Bechtel, Wilbur Smith, Kirber, Chapman, March 1971, described studies made to extend BART facilities to the airport. A total of 20 schemes were investigated to determine the best method of serving the airport. The

recommended scheme is a subway through the airport because it is aesthetically more pleasing than an aerial scheme and it will offer better transit service. Provisions are being made in the airport expansion program to physically accept BART when it is constructed. The report indicated that if BART were extended from Daly City through the airport to San Jose, 70,000 air-passenger-related trips might be expected after 1985 on a busy peak day. This could be a substantial diversion of air passengers from autos, but would be a small portion of the capacity of the BART line.

The RASS Final Report, on page I-17, states "... the assumption of the maximum percentage of passengers likely to use transit is raised from 18 to 23, in order to clearly make transit access a condition of the recommended plan." Furthermore, this figure of 23 is an average for three airports: San Francisco, San Jose, and Oakland. Wilbur Smith & Associates prepared a report that shows the potential transit passenger figures are 27.3% to 32.5% for San Francisco, 17.7% to 18.0% for Oakland, and 10.0% to 10.1% for San Jose.[4] This report is the basis for the airport access portion of the Final Report.

If BART is not extended to the airport by 1985, other types of mass transit would be developed. Currently, 15 percent of the air passengers use either the Airporter bus or Greyhound. This type of service could be expanded to provide transportation terminals for the Airporter bus in other locations such as San Jose, Palo Alto, and Oakland. In order to establish this type of additional service, the airport may have to subsidize service until patronage buildup is sufficient for the operator to make a profit.

4 Wilbur Smith & Associates, Airport Access, Bay Area Study of Aviation Requirements, ABAG, June 1970

O. EARTHQUAKES

The buildings to be constructed at San Francisco Airport are relatively low structures, three stories above the ground, and are expected to be relatively short period structures as compared with highrise buildings and would tend to have less damage than a highrise building constructed in the same area. These buildings are constructed on piles that are founded on bedrock, so the buildings do not rest on bay mud.

There is not enough actual experience with earthquakes to prepare dollar estimates of costs associated with earthquakes of a particular magnitude. Current design philosophy for all types construction (not limited to airports) is to design to minimize life hazard, and to restrict property damage to reasonable limits in the event of a great earthquake. There is no consensus on what constitutes a "reasonable limit" to earthquake caused property damage.

The Office of Emergency Preparedness prepared an internal report in 1972 titled "A Study of Earthquake Losses in the San Francisco Bay Area." This report was directed towards the vital human needs which are required immediately after an earthquake disaster. There are three sections to the report:

1. Effects on local medical resources
2. Demands on medical resources
3. Effects on immediate and vital public needs

Heavy emphasis was on 1 and 2, with lesser attention to other types of information.

Following is an excerpt from the report:

> The 1957 San Francisco earthquake had a magnitude of 5.3 and caused only minor nuisance damage at the San Francisco airport; the airport is located on structurally poor ground about 10 miles southeast of the epicentral region of the 1957 shock. Slowly occurring differential settlements around buildings were accentuated by the earthquake, and a number of underground pipelines broke as a result. Some minor structural damage occurred to several buildings, but no runway damage is known to the authors.
>
> The great Alaskan earthquake of 1964, with its 8.4 magnitude, provides a reasonable guideline for experience data from a great shock. A total of 13 airports were found to have had runway or taxiway damage out of 64 airports which were inspected. Virtually all airports were operational within hours after the shock despite runway damage and building damage. Some resourcefulness was required in order to accomplish this; for example, the collapse of the control tower at the Anchorage International Airport required the use of radios in a grounded plane for air traffic control. Runways remained functional at airports in the San Fernando Valley after the 1971 San Fernando shock.

The foregoing incomplete experience record is rather reassuring with respect to the most important function of an airport; namely, to allow airplanes to land and to take off with people and goods.

> Earthquake damage to airports can be divided into (A) damage to buildings and structures and into (B) damage to runways and taxiways. Damage to structures, in turn, can be subdivided into (a) damage to structures vital to the operational aspects such as control towers, fuel tanks and similar features and (b) damage to the less important service structures. While detailed information was obtained on the construction of a large number of airport buildings and it is reasonable to expect serious structural damage to some of the buildings, the emphasis of the following paragraphs is on the damage to runways and taxiways. In other words, we are relying on the ability of airports to remain functional after a disaster despite inconveniences and trusting to the leadership abilities of control tower management to find alternate and non-standard methods of communication.

San Francisco International Airport, Oakland International Airport, and Alameda Naval Airbase Airport are in regions of structurally poor ground (Bay mud areas), and Hamilton Air Force Base Airport soils are open to some question from a structural standpoint. In the event of high intensities at these four airports, the runways will be considered to be badly broken for planning purposes even though experience does not fully confirm this. The runways on the other airports are expected to remain in operation, or become operational again in hours.

Earthquakes on the San Andreas Fault — Expected Damage Patterns

For planning purposes, a magnitude 8.3 shock will close down the San Francisco International Airport, Oakland International Airport, Alameda Naval Airbase Airport, and Hamilton Air Force Base Airport. The non-operational period is expected to be in terms of weeks for the first mentioned airport, and with the others down for not longer than a week. Practical land access will not exist to San Francisco Airport due to freeway and highway damage which will effectively isolate the airport and nearby facilities.

A 7.0 magnitude earthquake is expected to close down only the San Francisco International Airport for several days, while a 6.0 magnitude shock is expected to leave all runways operational within hours at most.

Earthquakes on the Hayward Fault — Expected Damage Patterns

For planning purposes, a magnitude 8.3 shock will close down the San Francisco International Airport, Oakland International Airport, Alameda Naval Airbase Airport, and Hamilton Air Force Base Airport. The non-operational period is expected to be in terms of weeks for Oakland International Airport and for the Alameda Naval Airbase Airports, with less than a week for the other two. Practical land access will be severely restricted to the Oakland and Alameda Airports due to freeway and roadway damage.

A 7.0 magnitude earthquake is expected to close down only the Oakland International Airport and the Alameda Airbase Airport for several days, while a 6.0 magnitude shock is expected to delay operations for not more than a few hours.

The above indicates that the report was prepared primarily for disaster operations and assumed the worst case.

The return periods for the postulated earthquakes of magnitudes sufficiently large to produce damage at intensity VIII, IX, and XI (earthquakes of magnitude 6.0, 7.0, and 8.3 respectively) are 17, 32 and 170 years. A different analysis yielded an estimated return period of 5, 15 and 102 years for magnitudes of 6.0, 7.0, and 8.0, with a possible error factor of two.

The report indicates that the airport would be in damage zone IX for an earthquake of magnitude 8.3 or 7.0 on the San Andreas fault. The airport would be in damage zone VIII for an earthquake of magnitude 6.0.

Damage zones are described as follows:

VIII Steering of motor cars affected. Damage to Masonry C; partial collapse. Some damage to Masonry B; none to Masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decaying piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX General panic. Masonry D destroyed; Masonry C heavily damaged, sometimes with complete collapse; Masonry B seriously damaged. (General damage to foundations). Frame structures, if not bolted, shifted off foundations. Frames rocked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud ejected, earthquake fountains, sand craters.

Definition of Masonry A, B, C, D:

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Karl V. Steinbugge has discussed some of the aspects of designing for earthquakes, and portions of his book[5] are quoted below:

GROUND MOTIONS ON BAY FILLS

Research, particularly in Japan, is showing that the ground motions in structurally poor soils are different from those in rock. Actual soils beneath a particular building are usually very complex, with varying soil strata having different dynamic characteristics. Consequently, the practical case of Bay fills is very complicated. In general, ground oscillations become slower as seismic waves progress from bedrock through less competent materials to the building foundation. Evidence from small earthquakes also indicates that the amplitude of the ground motions becomes substantially greater in structurally poor grounds, as compared to rock. In other words, ground motions are amplified as they pass through less competent materials. This amplification has often been demonstrated in a crude fashion by vibrating a bowl of jellylike material.

The foregoing factors have not yet been incorporated into American building codes, partly because the information on them is too new and too incomplete. But these phenomena theoretically can become troublesome to long-period structures. (In lay terms, long-period structures are most commonly the high-rise buildings). A classic example of selective damage to tall buildings (i.e., long-period structures) compared to rigid one-and two-story buildings occurred in the Mexican earthquake of July 28, 1957. The earthquake was distant, its epicenter being reported as from 170 to 220 miles from Mexico City. There was pronounced damage to many of the tall reinforced concrete and steel frame buildings in downtown Mexico City. Several of them collapsed. In contrast, small one-and two-story "collapse hazard" buildings performed well.

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(5) Steinbugge, Karl V.: Earthquake Hazard in the San Francisco Bay Area: A Continuing Problem in Public Policy, University of California, Berkeley, 1968.

Soils in downtown Mexico City consist of unconsolidated lake bed and other materials, and they are of exceptionally poor structural quality. Ground motions from this distant earthquake selectively damaged the long-period (multistory) buildings. But multistory building damage was far more pronounced in the poor ground areas than in the nearby firmer ground areas. (Differential settlements obviously played a role in some of the damage, but the author's observations indicate that it was minor in most cases).

SEISMIC RISK FROM VIBRATIONAL FORCES

Architects and structural engineers have given more attention to the effects of vibrational forces in buildings than they have to the geologically oriented problems. Extensive engineering research, particularly in the last 10 to 20 years, has developed the basic theory for the understanding of earthquake forces on buildings, the response of the buildings to these forces, and design methods to reduce life hazard in these structures. All of these problems have by no means been fully solved, but expanding research is underway on remaining problems.

The fact that all problems have not been solved is clearly evident from the extensive damage to many buildings in Anchorage during the 1964 Alaskan earthquake. Most of the damaged buildings were designed to be earthquake resistive in some degree, most buildings were designed by recognized professional engineers, and most damaged buildings were built under construction standards common to many parts of the United States. Unfortunately, similar circumstances are found in other cities where a large earthquake can cause similar damage. In the next great earthquake, some Bay Area cities quite possibly will also witness the collapse of modern buildings, which probably had their counterparts in Anchorage in 1964.

Seismic risk can be viewed from different standpoints, with quite different results. For example, severe earthquake damage does not necessarily imply an equivalent hazard to human life. An earthquake may crack a building so extensively that repairs are uneconomical. Despite such damage, however, collapse — and consequent

injury or death of occupants — may not be a serious threat. During the 1964 Alaskan earthquake, major multistory buildings up to 14 stories suffered damage ranging up to 40 percent of a building's replacement value, without accompanying life loss. Conversely, the failure of light fixtures and shelving, or lighting loss in an auditorium, resulting in panic, are examples of life hazards in structures that sustain only minimum damage. The collapse of nonstructural hollow concrete-block partitions around stairs has also caused injury and death.

A commonly accepted viewpoint on seismic risk is to take such engineering design steps as may be necessary to minimize life hazard, and to restrict property damage to reasonable limits in the event of a great earthquake. There is, however, no consensus on what constitutes a "reasonable limit" to earthquake-caused property damage. Some engineers take an extreme viewpoint, being willing to allow total loss to their client's property, provided that life safety is assured. This viewpoint is also sometimes held by speculative developers who, through sale of the developed property, transfer the hazard to the unsuspecting buyer.

The basic philosophy behind the seismic provisions of most American building codes appears in the Recommended Lateral Force Requirements and Commentary by the Seismology Committee of the Structural Engineers Association of California (1967). This publication states that the code intends buildings to "Resist major earthquakes of the intensity or severity of the strongest experienced in California, without collapse, but with some structural as well as nonstructural damage." It goes on to state, "In most structures it is expected that structural damage, even in a major earthquake, could be limited to repairable damage." By using certain types of flexible, but "safe" framing systems in certain occupancies, such as hotels and hospitals, it is quite possible to suffer a 50 percent property loss without serious structural damage. (Design for damage control usually includes life safety, but design for life safety — i.e., minimum code standards — does not necessarily include damage control.)

In most cases the earthquake provisions of a building code, plus the design engineer's judgment, normally determine the seismic risk as it affects the design of any particular building or structure. Expert advice may have been obtained from engineering geologists,

seismologists, soils engineers, and others, but the design engineer must evaluate all reports and synthesize them into a judgment decision, sometimes influenced by the minimum standards of the building code. Unfortunately, in some cases all efforts are directed towards barely meeting the minimum earthquake standards of a building code. In fact, such minimal compliance places a building on the verge of being legally unsafe.

The foregoing is a brief statement of the nature of seismic risk for new construction. In summary, earthquake-resistive construction, which protects life, is realistically feasible, although earthquake-proof construction is not guaranteed in new buildings.

P. Tsunami Impacts

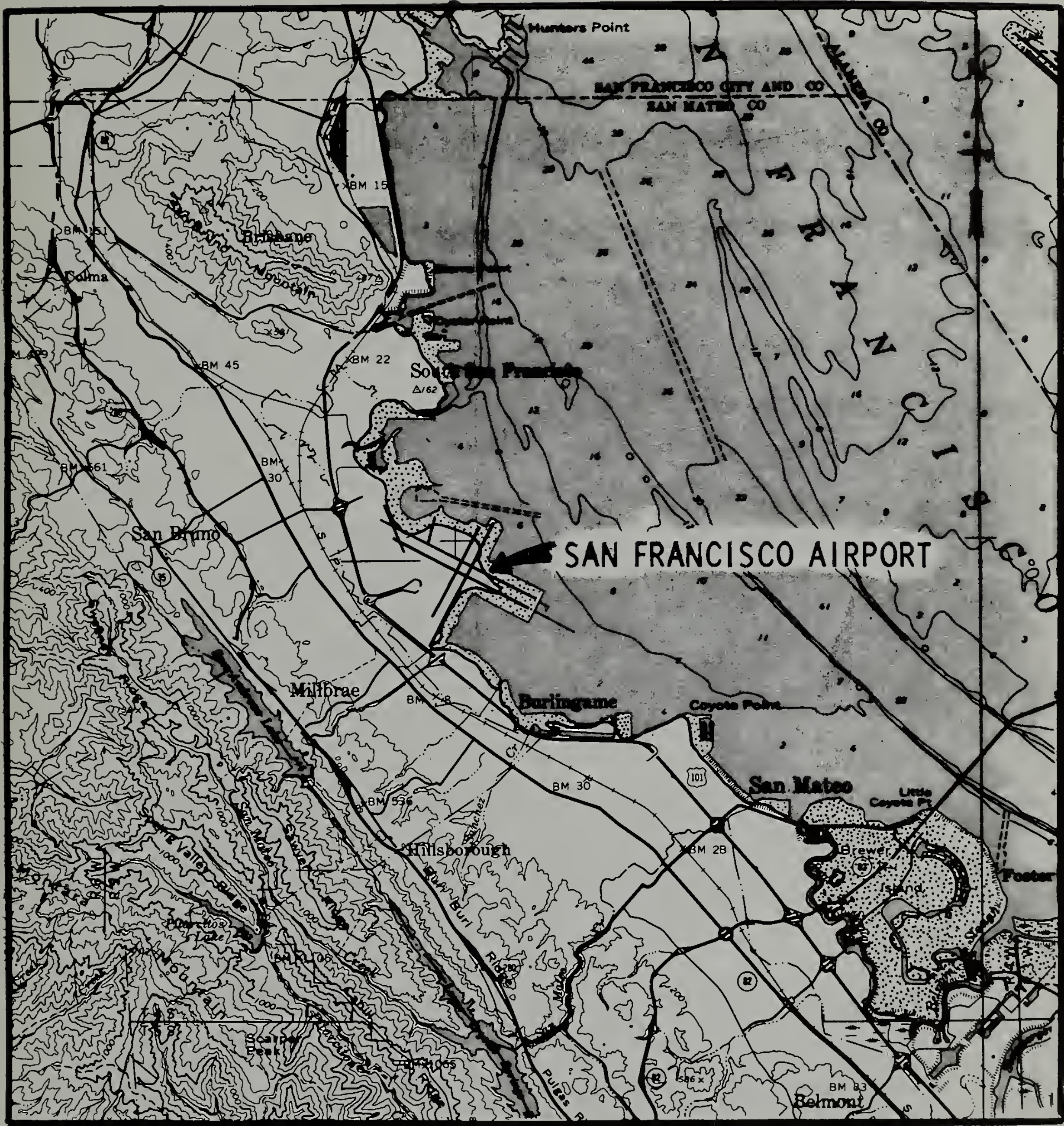
The Department of Interior, United States Geological Survey, prepared a tsunami map in 1972 that assumed a 20-foot-high wave at the Golden Gate Bridge, and showed the water runup along the ends of runways 19L and R and 28L and R and the seaplane harbor area. This is shown on Figure 2-9. The passenger terminal area and air cargo areas are not shown as being affected. A 20-foot tsunami wave may arrive at the Golden Gate once every 200 years. Because the public areas are not in tsunami runup area and the occurrence is infrequent, the tsunami effect on the development and the hazard cost would be small.

The tsunami was assumed to occur at a tidal stage of average higher high water, a stage which is equaled or exceeded about 4 percent of the time at the Golden Gate. The tsunami runup is estimated to decrease 1 percent with distance travelled over land, or 1 foot for every 100 feet of travel.

The report Geologic Hazards and Public Problems by the Office of Emergency Preparedness, 1969, indicates that there is no resonance for tsunamis in San Francisco Bay. The waves come in and dissipate. As the tsunami waves come into San Francisco Bay, they decrease in height, scatter, and dissipate their energy. Damage inside San Francisco Bay is due essentially to the horizontal motion of the water, currents, which causes ships which are not moored properly for this particular type of current to break loose and cause damage.

Q. Conservation of Fuel

The jumbo jets, based on a passenger mile basis, are more fuel efficient than the automobile. The automobile is the primary means of inter-city traffic. Buses and trains are more efficient per passenger mile than



SOURCE: USGS

Area that may be inundated by tsunami waves with a runup of 20 feet at Golden Gate.

FIGURE 2-9

TSUNAMI RUNUP AREA

SCALE 1:125,000

either the car or airplane, but are not used significantly in inter-city travel by the United States society. This society has continued to increase its use of inter-city transit and has selected the method of transit primarily by convenience without regard for conservation of fuel.

Transportation forms and their equivalent efficiencies are listed below:

			Equivalent Passenger Miles Per Gallon
1.	Bicycle	(100% occupancy)[a]	1000
2.	Train	(50% occupancy)[b]	75-100
3.	Large Bus	(58% occupancy)[b]	125
4.	Automobile	(25-50% occupancy)[b]	12-32
5.	747	(61% occupancy)[c]	26
6.	L-1011	(61% occupancy)[c]	23
7.	DC-10	(58% occupancy)[c]	21.5

Sources: a Rice, R.A., Technology Review, January 1972, pg 37

b Rice, R.A., ASME 70 WA/ENER-8, Nov. 1970, Table 12

c Derived from data in Aviation Week & Space Technology, December 18, 1972, pg 27

In the past, the U.S. public has elected to use transportation based on convenience first, with other factors being of lesser importance. The use of inter-city transportation between 1950 and 1970 is illustrated on Table 2-7.

Table 2-7 shows that the automobile, a relatively inefficient (from a fuel consumption standpoint) means of transportation, was used the most. Airways absorbed an increasing percent of the inter-city travel, increasing at the expense of the more efficient (from a fuel consumption standpoint) train and bus.

Table 2-7

INTER-CITY TRAFFIC VOLUME IN BILLIONS OF PASSENGER MILES

Year	Total Volume	Personal Auto		Airways		Bus (except school)		Rail		Inland Waterway	
		Volume	% of Total	Volume	% of Total	Volume	% of Total	Volume	% of Total	Volume	% of Total
1950	508	438	86.2	10	2.0	26	5.2	32	6.4	1.2	0.2
1960	784	706	90.1	34	4.3	19	2.5	22	2.8	2.7	0.3
1970	1,185	1,026	86.6	119	10.0	25	2.1	11	0.9	4.0	0.3

Source: 1972 Statistical Abstract of the U.S.

The amount of petroleum output for 1960 and 1970 is listed below:

Petroleum Output in Millions of Barrels at 42 Gallons

	1960 Barrels (1,000,000)	% of Total	1970 Barrels (1,000,000)	% of Total
Gasoline	1,510	48.7	2,100	49.5
Jet Fuel	88	2.8	302	7.1
Other	1,521	49.5	1,850	43.4
Total	3,119	100.0	4,252	100.0

Source: 1972 Statistical Abstract of the U.S.

The above table indicates that aviation fuel is a small but growing percentage of the total petroleum market. This table tends to exaggerate the growth of aviation fuel because in 1960 there were few domestic jets flying and many piston engine aircraft flying that used gasoline instead of jet fuel. Between 1960 and 1970, most of the piston engine aircraft were phased out.

Because of the way the general public uses transportation, the jumbo jet airplane is more efficient per passenger mile than the car because of the low seat occupancy of the car. The fuel consumption per passenger mile of the jumbo jet in the third quarter of 1972 is as follows:

Aircraft	Passenger Miles Per Gallon	Percent Seat Occupancy
747	26	61.4
L-1011	23	61.4
DC-10	21.5	49.6

Source: Aviation Week and Space Technology, December 18, 1972, pg 27.

The average car provides 18.7 passenger miles per gallon, assuming an average of 1.5 occupants per car and 12.5 miles per gallon. The 1.5 figure is slightly higher than the 1.3 figure reported for occupants in private autos to the airport. The 12.5 miles per gallon is a figure used in 1972 EPA report for calculating auto emissions.

Aircraft design is running through a cycle where it was relatively efficient per seat mile and then dropped in efficiency, and is now back to the same efficiency. The following table gives the summary:

Aircraft	Typical MPH	Total Seats	Fuel GPM	BTU per Seat-Mile	Weight per Seat, Tons
DC-2	150	18	0.4	2,700	0.67
DC-6/Constellation	270	56	1.5	3,200	0.89
DC-8/B707	525	130	4.2	4,000	1.07
B747	575	350	7.4	2,700	0.92
DC-10/L-1011	525	280	5.7	2,600	0.72

Source: Rice, R.A. Historical Perspective in Transport System Development, May 1970

The expansion of San Francisco Airport will allow more of the larger, more fuel efficient aircraft to use the airport.

The foregoing information indicates that the automobile is a prime user of petroleum and based on a passenger mile basis, the new aircraft are more efficient than the automobile. Buses, while much more fuel efficient on a passenger mile basis are not a popular form of inter-city travel. Rapid rail transit is another relatively efficient inter-city carrier, but is not in general use. Information on rail rapid transit is provided in the section on alternates.

The potential fuel shortage is of national concern and must be solved at the national level. However, of the 4,252 million barrels of petroleum produced in 1970, aircraft at San Francisco International Airport used 15.9 million barrels or about 0.37%.

R. Fill

Project L2, North Airport Fill, was commenced in March 1969 and completed in August 1970. This was carried out under a permit from BCDC. In connection with this fill a fish breeding area was provided by making islands and sand and rock spits off the fill.

Project L3, West of Bayshore Fill, was commenced in September 1969 and completed in 1970. The area was formerly leased out for grazing of cattle. The State Public Health Engineer and the San Mateo County Vector Control Specialist feel that this fill will significantly reduce the periodic problem of mosquitoes and rodents in this area, which will improve the environment.

The filling of the Seaplane Harbor and the associated roads and facilities in that area does not affect the remainder of the Expansion Program. A separate Environmental Impact Report is being prepared for this fill project and it is recommended that these projects be deferred until after finalization of the Impact Report.

No bay fill is required for the extension of Runway 28-R. This area was filled in 1969.

S. Air Freight

Air freight aircraft operations are not expected to materially increase by 1985. The major reason is that as the larger jets come into airline use, their lower compartments have a large volume for accommodating cargo. For instance, a TWA 747 has 5,550 cubic feet of lower compartment space as compared to 1822 cubic feet of lower compartment space in a 707 and an all freight 707's total space of 7,610 cubic feet. The 747 passenger aircraft can carry in its lower compartment 3/4 of the load of an all freighter 707. Space utilization of the lower compartments of the existing large aircraft have been running in the neighborhood of 22 percent of capacity. This is an indication that passenger aircraft will have a large potential to carry freight since there will be more of them and the existing capacity is underutilized for cargo. The fleet of all cargo aircraft has been shrinking since 1970. Americans' freight fleet went from 16 aircraft in 1970 to 14 in 1972. TWA's has slipped similarly, from 13.2 in 1970 to 11.6 in 1972. United's number of freighters has remained steady. Pan American's all-cargo fleet has dropped from 22 prior to introduction of the 747 to 16 in 1973.

Except for 1966-1967, the last decade has been characterized by operating losses in domestic all-cargo service for both the combination and all-cargo airlines. The airlines are not buying new all-freight aircraft in the near future because they are losing money on their all-cargo operations and they have available cargo space to fill in their passenger aircraft.

T. Impact on Bay of Air Turbulence

Turbulence effects on the Bay from aircraft operations: Turbulence on the Bay caused by aircraft is from two separate effects. One effect is jet blast created by aircraft at the ends of 28L or R and 19L or R as the aircraft

apply full power for takeoff. The jet engines create a 35 mile per hour wind effect to 320 feet behind a 747 and out to 100 feet each side of the runway centerlines at breakaway thrust. The Bay is approximately 300 feet from the end of the runway, so the effect on small boats will be minimal.

A second effect is that large jet aircraft such as the 747 and DC-10 create a vortex behind the aircraft as it flies. This vortex may remain for six minutes in still air or is broken up in 2 minutes with winds of 10 miles per hour. The vortex settles below the aircraft flight path. Near the ground a "cushion effect" starts and the vortex settling changes to a lateral movement perpendicular to the aircraft flight path and about a half-wingtip distance (100 feet for the 747, 75 feet for the DC-10) above the ground. No studies have been documented for a cushioning effect over water, but it is expected to be similar to land, and hence the effect on the bay or small boats on the bay under the landing flight path is expected to be minimal.

U. Impact on San Carlos Airport and Half Moon Bay Airports

The RASS final report indicates that general aviation activity at San Francisco Airport will remain constant at about 30,000 annual operations. However, that report indicates that general aviation activity will grow in the Bay Area. In San Mateo county, the growth will be concentrated at San Carlos and Half Moon Bay, unless a new general aviation airport is constructed. The commercial aircraft use of airspace will be similar in 1985 to that of 1970 insofar as San Francisco is concerned. Therefore, the airport expansion should have no effect on the flight patterns at the Airports of San Carlos and Half Moon Bay.

V. West of Bayshore Development Impact

The West of Bayshore Development, as conceived in the master plan prepared in 1968 by Wilsey and Ham of San Mateo, involved the conversion of existing pasture land to a light industrial area. Of the original 180 acres considered for development, only about 50 acres have been filled; and no more fill is contemplated as part of the proposed expansion program. Prior to filling the 50 acres, the land was leased for pasture use. Even though there was considerable standing water in the area during the rainy seasons, available pump capacity drained the area quickly. There was no area that could be considered a fresh-water marsh.

The project included in the expansion program is to complete the utility and road development for the 50 acres of filled land. The storm drainage canal has already been rerouted as proposed by Wilsey and Ham. The pump station lifting the water into the high-level Millbrae Canal has been re-equipped with large diesel pumps and experienced no difficulty in coping with the excessive runoff of the 1972-1973 winter.

Sanitary sewage connections will be made to either the SFIA sewage treatment plant or to the system of an annexing community, if such annexation goes forward. The main water supply to SFIA is considered adequate to supply the developed area.

Although no specific provisions have been made, it is anticipated the developed area will attract airport-oriented light industrial, commercial and educational facilities such as:

- Rental car storage and maintenance
- Remote parking for passengers and airport employees
- Freight brokers
- Ground support equipment rental and maintenance
- Aircraft parts warehousing and distribution
- Manufacturer's technical representative offices
- Airline crew training facilities
- Aircraft maintenance training school

With the possible exception of the latter two, all these facilities are capital intensive and will not require a substantial influx of employees. No manufacturing or other noisy facilities are anticipated. It is expected that the added demand for power, gas and water will be minimal.

The advent of I-380 and its various access and frontage roads will mark the commencement of usefulness for the West of Bayshore property because only then will adequate ingress-egress routes be established. It is expected that most traffic in the area will be of a commercial nature, arriving from and departing to either Bayshore Freeway, I-380 or the airport proper. Traffic from the San Bruno-Millbrae area should largely be limited to employees who happen to live in those two cities, or from local merchants supplying the various facilities in the development.

W. Environmental Controls During Construction — Proposed Method Of Accomplishment

The major construction activities for the new terminal facilities where environmental quality may be a problem will include changing the existing terrain for automobile parking and aircraft parking; installing crushed rock under areas to be paved with asphalt; paving with asphalt, paving with Portland cement concrete in certain aircraft parking areas; and construction of the terminal buildings.

The construction materials for these activities will be obtained from existing suppliers, quarries, and asphalt plants in the area. The contractors will be required to operate in accordance with existing pollution control methods. Provisions will be included in the construction specifications to ascertain that the criteria for environmental controls during construction are met. Recommendations from Federal Aviation Agency (FAA) Advisory Circular AC 5370-7, Airport Construction Controls to Prevent Air and Water Pollution, will be included. The contractor will be required to maintain all excavations, embankments, haul roads, access roads, plant sites, waste disposal areas, borrow areas, and all other work areas within or without the project limits free from dust that would cause a hazard to the work or to persons or property.

Construction access will be by existing public roads. Large trucks and heavy construction equipment will be prohibited from using the main access road unless there is no other feasible route.

The emission of smoke, dust, or other air pollutants from asphalt plants, rock quarries, concrete plants, and other construction equipment is under the control of the Bay Area Air Pollution Control District, which issues permits for such equipment when the equipment is in conformance with their requirements.

Noise will be generated by construction of the airport expansion. Freeway traffic and aircraft operations have effectively "masked" any construction noise in this area in the past. The major portion of the expansion is east of the Bayshore Freeway, approximately 3,000 feet from residential areas. Construction in the airport property west of the Bayshore Freeway was primarily fill and the installation of utilities. Construction work is normally accomplished during daytime hours from 7:00 A.M. to 4:30 P.M. Construction work in the evening or night is done only for emergencies or to eliminate operational problems.

Water that has to be pumped out of any construction area is routed to the existing storm drain system. The storm drain system has two detention basins where solids and large contaminants are settled out before the water is discharged to the bay.

Waste materials from construction will be disposed of as legally required. Raw sewage will be disposed of at the sewage treatment plant.

SECTION THREE

Section 3

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

One environmental effect which cannot be avoided is an increase in vehicle traffic on the airport and on the roads leading to the airport.

An increase in the solid and liquid wastes generated is unavoidable. This increase has been anticipated in the design of the sewage-treatment plant and will be incorporated in the industrial waste-treatment plant.

The increase in water, natural gas, electricity, and aviation fuel consumption is unavoidable because these are necessary ingredients for accommodating increased passengers.

SECTION FOUR

Section 4

MITIGATION MEASURES TO MINIMIZE IMPACT

The Regional Airport Systems Study Committee reviewed the overall environmental impact on the San Francisco Bay Area and concluded that preferential expansion at San Francisco International Airport would most effectively mitigate the regional impact, since this airport is already more accessible than the other area airports and can have an expanded capacity with a minimum of acquisition or creation of new land areas.

The proposed San Francisco International Airport Expansion Program, in turn, incorporates a number of significant measures to mitigate the impact on the local environment:

- The Expansion Program has been designed to take place within existing boundaries so that no land acquisition with attendant displacement of people is required.

- The Expansion Program includes facilities that will allow an increased use of the new larger and quieter aircraft. This permits increased passenger traffic without increasing the number of airline operations. This will contribute to reducing noise levels that could otherwise occur.

- The Expansion Program does not include any new runways because the increased passenger traffic can be accomodated by improving the existing runways to allow more use of the larger aircraft. The extension to Runway 28R over existing fill has been included in the Expansion Program to make the take-off threshold for this heavily-used runway more distant from the communities under the flight path, thereby permitting improved operations measures and further reducing the noise impact.

- The Expansion Program includes two high-speed exit taxiways which will enable aircraft to leave the runways sooner and at higher speed, thereby allowing them to minimize thrust reversals and still arrive at the loading gates sooner. This will alleviate noise, consume less fuel and, in turn, reduce air pollution.

- The Expansion Program has provided for additional close-in, covered bus parking areas which will encourage and promote this mode of transportation.

- The Expansion Program incorporates substantial increases in curbside loading facilities, close-in parking and convenient access and egress for those who must use automobiles, so there will be improved passenger convenience and less traffic congestion with its attendant engine-idling for large numbers of automobiles. These improvements will contribute to the reduction of air pollution from automobile emissions.

- Provisions to assist adjacent communities in improving road intersections that join the airport frontage roads have been recommended for inclusion in the Expansion Program; improvements to the frontage roads themselves have already been included. These improvements will, together with the construction of Interstate 380, help relieve the congestion on the streets of nearby cities.

- The Expansion Program includes facilities for more complete treatment and better handling of both domestic and industrial liquid wastes. These facilities are sized to accommodate the increased quantities anticipated. The projects include a domestic sewage-treatment plant already completed, an industrial waste-treatment plant and collection system, and a joint Airport-City of South San Francisco deep-water outfall. Therefore the quality of effluent entering the Bay will not only be improved, but will be more effectively dispersed into deeper waters.

- The Expansion Program calls for provision of modern solid waste collection and compaction systems which will minimize the volume of solid waste being disposed off the airport site.

- The Expansion Program provides for integrated heating, cooling and electrical systems to give more efficient utilization of fuel and power.

- The Expansion Program is under the architectural and aesthetic control of one firm so a unified visual effect will be achieved. Budgets of $2, 000, 000 and $850, 000 have been established for art enrichment and landscaping, respectively.

- Small islands to provide protected fish-breeding grounds and rock spits were provided in conjunction with the North Airport fill project. The plans for this work were approved by the Department of Fish and Game.

- The West of Bayshore Fill significantly reduced the periodic problem of mosquitoes and rodents in that area.

- A noise-monitoring program is being implemented so that accurate data will be available to describe aircraft noise. This will aid in implementing future noise-reduction programs.

- A pollutant-monitoring system is being recommended for inclusion in the program to check fallout from aircraft emissions where there is a possibility of health-endangering conditions.

- The Expansion Program is incorporating structural provision for a possible extension of the Bay Area Rapid Transit (BART) to the airport. These provisions will make such an extension less costly and less disruptive to on-going operations during construction. If BART is extended to the Airport, it is expected to reduce reliance on the automobile and, hence, reduce the amount of automobile congestion and air pollution.

SECTION FIVE

Section 5

ALTERNATIVES TO THE PROPOSED DEVELOPMENT

The alternatives to the proposed development which were considered include:

a. No expansion program at the San Francisco International Airport

One of the alternatives to the Expansion Program for the San Francisco International Airport is to "do nothing." Doing nothing in this instance would mean leaving the facilities at the airport as they are today. This alternative would have the advantage of not requiring a large capital expenditure of funds at this time.

The "do nothing" alternative depends upon either of two basic assumptions. One assumption is that for no population growth there would be no need to expand the present facilities since the demand for air transportation at San Francisco International Airport would remain constant at about 15 million passengers annually, and this number could be accommodated with the present facilities. Or secondly, if there were an increased demand for air transportation, it could be satisfied by air transport from another Bay Area airport.

The assumption that for a stable population there would be no passenger growth has not been demonstrated in the past. The relationship of air travel passenger growth to population increase in the Bay Area over the last twenty years is revealing: population has increased from 2,681,322 in 1950 to 4,628,000 in 1970 or about 1.8 times, while air passengers have gone from 2,000,000 to 17,500,000 in the same period, for an eight-fold

increase. Over the last ten years examined, between 1960 and 1970, the statistics are even more startling: with less than a million increase in the Bay Area population, there has been 12,500,000 air passengers per year increase. These statistics reflect two trends -- the younger generation is traveling more by air than those of previous generations and affluence fosters air travel. So with even a stable population we can anticipate an increased demand for air travel from the younger generations for whom air transportation is not a novelty but a necessity. Also, at the present time over 40 percent of the air passengers using San Francisco International Airport are not residents of the Bay Area but are visiting here on either business or pleasure. If our society becomes more affluent, this percentage is expected to increase. So that even with a stable population in the Bay Area we must anticipate a sizable growth in air passenger demand for transportation. If no provisions are made to handle this increased demand, congestion and inconvenience will result.

The alternative to "do nothing" at San Francisco International Airport, if adopted, would have an adverse impact on the environment in the vicinity of the Airport from several aspects. Noise and air pollution effects from aircraft will remain as they are now since the quieter, cleaner, wide-bodied aircraft cannot be substituted for the noisier, dirtier, smaller aircraft, due to terminal area restrictions. Also the noise impact reduction anticipated from extending runway 28R away from San Bruno would not be realized. With no additional vehicle parking in the area of the terminal, there will be increased congestion, with slower-moving traffic burning more fuel with a consequent greater emission of pollutants. Without the planned additional waste treatment plants, the effluents discharged into the Bay will not be as free of pollutants as would be possible.

The second situation assumes that other Bay Area airports will carry the load of the Bay Area traffic over and above the 15 million passengers at San Francisco International Airport. The problems of expanding other airports to meet the RASS-recommended loads are even more severe than those facing San Francisco. Ground access to Oakland is more restricted than at San Francisco. In order to meet the forecast needs set out in the approved Bay Area Airport regional plan, Oakland International Airport must expand 12 times, and San Jose Airport must expand 5 times their operational capacity. An expansion of this magnitude at Oakland International Airport will require Bay fill to provide for a new runway, which, of course, has an adverse impact on the environment. San Jose, as documented in the RASS reports, has a more severe air quality problem than San Francisco, and appears to have a severe noise problem.

b. Use other transportation systems

An alternative to developing the airport further is to provide an alternate means of transportation. One possible solution is to develop a rail rapid transit system. The logical first leg of this transit would be a line running between the San Francisco area and the Los Angeles area. This line could be extended to other major metropolitan areas.

No definitive studies have been completed on such a rapid transit system between San Francisco and Los Angeles to date. However, the Rand Corporation of Santa Monica, California, is engaged in exploring a high-speed surface system. The report from this study should be finished in the summer of 1973. Two surface transportation methods are being explored:

1. Use of tracked air cushion vehicles
2. Use of the present rail facilities, with the facilities being upgraded

Preliminary findings indicate that the tracked air cushion vehicle is technically possible but would have such high cost that it could not pay for itself and a subsidy would be required.

Present rail facilities could be upgraded with straightening of some curves, and a majority of the rail could be located on existing rights-of-way. This would allow operation of vehicles of up to 130 miles per hour. The improved cars would be designed to perform carefully and safely at such speed. Even with the improved speed and minimal upgrading, it appears that a subsidy would still be required. Also, such a system is not expected to be able to be put into operation until after 1985.

The Regional Airport Systems Study also considered the concept of Short Takeoff and Landing (STOL) aircraft. While this system shows promise, it is not yet economically and operationally viable and is not expected to be operational before 1985. These systems may, however, lower the total demand for air travel by the year 2000 from about 240 million to 150 million annual passengers.

c. Alternatives considered in the Regional Airport System Study

Various combinations of expanding existing airports were investigated in the Regional Airport Systems Study.

Alternative No.	Airport	Future Annual Airport Passengers Enplaned and Deplaned (millions)
1	SFO	32.650
	Oakland	34.314
	San Jose	16.500
		83.464
2	SFO	37.884
	Oakland	24.100
	San Jose E (new)	21.480
		83.464

3	SFO	32.540
	Oakland	13.780
	Hollister (new airport)	30.774
	Hamilton Air Force Base	2.678
	Buchanan Field	2.392
	Livermore Airport	1.190
		83.464
4	SFO	32.650
	Oakland	13.780
	San Jose	7.500
	Travis Air Force Base	29.534
		83.464
5	SFO	37.884
	Oakland	22.007
	San Jose	16.500
	Sonoma County Airport	2.678
	Richmond (new airport)	4.395
		83.464
6	SFO	32.650
	Oakland	17.000
	San Jose E (new)	33.814
		83.464
7	SFO	32.650
	Oakland	8.814
	San Jose E (new)	42.000
		83.464
8	SFO	32.650
	Oakland	13.780
	San Jose	7.500
	Napa County Airport	2.689
	Hollister (new airport)	26.845
		83.464
9	SFO	32.650
	Oakland	43.314
	San Jose	7.500
		83.464
10	SFO	32.650
	Oakland	24.100
	San Jose	16.500
	Napa County Airport	10.214
		83.464
11	SFO	32.650
	Oakland	13.780
	San Jose	7.500
		53.930

12. A regional mid-Bay airport with BART connections to replace SFO and Oakland. This new airport would have two sets of parallel 12,000-foot runways over 2,000 acres of fill. The intention is to relieve noise impact, improve retail accessibility, and replace separate SFO and Oakland Bay fill. SFO and Oakland would be used for parking and terminal functions.

13. A new regional airport in eastern Contra Costa County

14. A new airport in southern Sonoma County (North Bay)

After the reports were published, a number of public meetings were held. The meetings established that the public did not want new airport sites created because of environmental considerations. This eliminated Site E, North Bay, and mid-Bay. The eastern Contra Costa County site was eliminated because of the average one-way trip distance of 70 miles.

After considering all of these alternatives, the Regional Airport Systems Study recommended that the airports in the Bay Area be developed to the following annual capacities:

SFO	31 million
Oakland	24 million
San Jose	10 million
Travis Air Force Base	6 million
Hamilton/Napa	1 million
Total	72 million

SECTION SIX

Section 6

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term uses of the land on which this project is being planned differ only in degree from the long-term uses. The accomplishment of this project will maintain and enhance the long-term productivity of the land by providing facilities which can accommodate twice the present passenger load.

No detrimental effects on the natural environment are anticipated from the accomplishment of the Phase II projects covered in this Environmental Impact Report. The entire expansion is being carried out within the present airport boundaries and the only Phase II project involving Bay fill is the subject of a separate and distinct Environmental Impact Report. Waste-water quality will be improved, and provisions are being made to monitor air quality in order to be able to take corrective action should this be necessary.

Regarding the human environment, this will be degraded to the extent that more vehicles will be travelling to and from the airport. In this respect, there is a trade-off between the disadvantages of increased vehicles and the advantages of providing safer, less congested, and more convenient conditions for air passengers. Neither noise nor pollution from aircraft will increase as a result of the expansion and monitoring systems are included in the program to safeguard against this.

SECTION SEVEN

Section 7

IRREVERSIBLE ENVIRONMENTAL CHANGES INVOLVED

Implementation of the expansion program will require the expenditure of the following resources:

- Construction material for buildings and pavement
- Construction material for building furnishings
- Energy supplies for heating and cooling buildings
- Manpower for construction
- Money for construction

Economic and social benefits must be considered to determine if the long-range gains to the political, social, economic and ecological whole are of sufficient advantage to justify the project.

Part of this review is the consideration of the expenditure of the resources listed above. In order to put this in perspective, it is appropriate to see what portion the use of these resources amounts to in the project area, compared with other public works.

To compare the expenditure of resources on the project with annual expenditures of such resources in San Francisco and San Mateo Counties and in the State of California, 1970 data has been reviewed. San Mateo County figures are included since the San Francisco International Airport is located within that county. It is noted that the project's construction period is expected to be 10 years, while that of the counties and the State, as shown, are for one year.

The average annual cement use will amount to 18 percent of the two counties' 1970 usage and 1.2 percent of the State's 1970 usage.

The average annual amount of sand, gravel and stone estimated for the airport expansion will represent 2.7 percent of the 1970 use in the two counties, and 0.08 percent of the State's 1970 usage.

Steel will represent 7 percent of the two counties' and 0.4 percent of the State's 1970 use.

Estimated Consumption of Selected Construction Materials

	Estimated Average Annual Demand for 10 yr Project	San Francisco	San Mateo	California
	in thousands			
Cement, Tons	11.7	40	24	947
Sand & Gravel, Tons	107.7	2,460	1,485	140,259
Stone, Tons	53.0	2,550	1,102	46,399
Construction Steel, Tons	4.3	44	19	1,035
	Cost Reference			
Annual Value of Construction	$31,800	$238,366	$143,346	$5,721,189

Notes: Tonnage figures -- from the Minerals Yearbook of the Department of the Interior. Where data were not given, these were estimated based on construction ratios of the counties to the State.

Value of construction -- California State Chamber of Commerce -- Economic Indexes -- Building Permits

Not all of the buildings for which permits are obtained are built in any given year. Some may not be built at all, and some will cost more or less than estimated. The building permits tabulation is, however, an excellent indicator of what is built in the location shown, as well as the general costs thereof. The average annual figure is used for comparative purposes only. In some years, airport construction materials will be above the average and in some years below the average.

The expansion program will provide a more efficient heating and cooling system, but the net result is an increase in energy expenditure over the existing terminal buildings.

The value of labor in total construction cost in the San Francisco Bay Area ranges from 30 to 45 percent. The reason for this spread depends on whether the type of construction is labor or capital intensive. For a building which has a relatively high labor component, labor would tend to constitute about 45 percent of the total construction cost. For an earthmoving job, runway or other capital intensive project, the labor component would be about 30 percent of the total job. These percentages would provide an average of 670 construction people working for the duration of the expansion program.

With respect to the annual outlays of money shown above, the funds shown for the Counties and the State are for public projects funded mainly from tax revenues, and private projects. The funds to be used for the Airport expansion are to be primarily from General Obligation or Revenue bonds which will be repaid in their entirety from revenues from the airport's operation. In view of this, these funds would not be available for other purposes.

SECTION EIGHT

Section 8

GROWTH-INDUCING IMPACT

The proposed expansion program is to provide the facilities for air transportation as demanded by the flying public. Of the projected 1985 air-passenger demand in the Bay Area, San Francisco International Airport is being designed to handle less than 30 percent of the increase. This increase in capacity, although it doubles the present usage of San Francisco International, will induce only moderate population and employment growth in the immediate vicinity .

An airport is a public facility, provided to fill an existing or projected public need. If provided in advance of need, the facilities remove potential obstacles to growth; if provided only after the need becomes urgent, the lack of facilities inhibits growth due to extreme congestion. It follows that the timing of development of public facilities is most important.

The Regional Airport Systems Study (RASS) indicated that population is not a major reason for air-passenger increases. The past increases are illustrated below.

San Francisco Bay Area

	Population	Total Air Passengers	Passengers Per 1000 Population
1950	2,681,322	2,000,000	746
1960	3,638,939	5,000,000	1380
1970	4,628,000	17,500,000	3780

The mathematical air-passenger forecast equation used by RASS contained three variables: income, employment, and population. While 72 million air passengers for the Bay Area was the most likely figure expected in 1985, a change in the forecast assumptions could yield different results. For instance, assuming zero population growth, and no change in per capita income and employment, 57.9 million annual passengers in 1985 would result. The 72 million annual passengers would not be reached until several years later.

If population is held constant and per capita employment and income increase by approximately 30%, total annual Bay Area passengers would increase to 95.5 million passengers and outlying airports would have to be extensively developed because San Francisco, Oakland, and San Jose would be at their maximum capacities. This illustrates two possible alternatives for zero population growth, and the forecast for San Francisco is still at its maximum capacity of 31 million passengers annually at some date near 1985.

Over 40 percent of the air passengers using San Francisco Airport are not residents of the Bay Area. They are businessmen, sightseers, and relatives living elsewhere and coming to San Francisco for business, pleasure or personal reasons. This, again, emphasizes that air passenger increases do not necessarily mean population growth.

The San Francisco Airport Expansion Program is expected to be complete in 1981, but the passengers are not expected to reach 31 million until 1985. There are several reasons for this. Providing complete facilities slightly in advance of need will relieve congestion as compared with the opposite of construction after the passengers are already trying to use the facility. The 31 million in the year 1985 is a projection and subject to normal statistical variations. The final RASS report indicates

that the 72 million Bay Area passengers for 1985 could actually appear in the time frame between 1982 and 1988 instead of exactly 72 million annual passengers in 1985. This same variability is to be expected at San Francisco.

The forecast of 31 million passengers annually in 1985 at San Francisco could be reached at an average annual passenger-increase rate of 5.5 percent per year. This rate of increase per year is less than the 9.6 percent per year achieved between 1950 and 1960 and much less than the 15 percent per year average passenger-increase rate between 1960 and 1970.

The final RASS Report took into consideration the need for better utilization of aircraft and changed load factors from 47 percent in 1985 to 60 percent in 1985. This reduced annual airline operations from 442,000 to the 310,000 which can be accommodated in 1985.

SECONDARY IMPACT

A secondary impact is a result of a primary impact of an action. For example, if an expansion of an industry created 1,000 additional jobs as a primary impact, a secondary impact would be additional employment opportunities created to provide for the everyday needs of the 1,000 additional basic employees, such as barbers, tailors, etc.

The secondary impact of airport expansion was studied at some length by the Institute of Transportation and Traffic Engineering (ITTE) of the University of California, Berkeley, in 1971. The Institute's report "Economic and Spatial Impacts of Alternative Airport Sizes and Locations in the San Francisco Bay Region", which was prepared for the Association of Bay Area Governments (ABAG) in their overall airports planning program, was a result of those studies. Although the program adopted by

ABAG differed from the alternatives studied by ITTE, several alternatives are sufficiently close to the adopted program for realistic comparisons; these are shown in the table below.

ALTERNATIVE AIRPORT SYSTEMS:
ESTIMATES OF ANNUAL PASSENGERS DURING 1985*

(Thousands)

Airport Location	Alternative Airport Plans 1	4	8	9	10	Final Estimate
San Francisco	32,650	32,650	32,650	32,650	32,650	31,000
Oakland	34,314	17,000	13,780	43,314	24,100	24,000
San Jose	16,500	7,500	7,500	7,500	16,500	10,000
Hollister			26,845			
Travis		26,314				
Napa			2,689			
Total	83,464	83,464	83,464	83,464	83,464	72,000

Secondary impacts of ten demographic social and economic features were reviewed in conjunction with the several alternatives shown above as they relate to San Mateo County. Table 8-1 shows a range of expected impact results with an indication of the most probable for the final estimate.

It is noted from Table 8-1 that the range in the several indices is as much as 100 percent in the case of non-residential land acreage change. This is a result of the extremely small base for the estimate. Of the other nine items, the range is from 0.3 percent to 17.1 percent. It is noted further that the alternate number 10 is most nearly like the expected. A statistical assessment of the 31,000,000 vs 32,500,000 total forecast passengers for San Francisco will give just slightly higher results than those shown for alternative 10 for four items, the same for three items and little less for three items. These are shown as probable.

* Goldner, et al Economic and Spatial Impact of Alternative Airport Locations, Regional Airport Systems Study, Volumes 1 and 1, ABAG, July 1971

Table 8-1

ESTIMATED CHANGES FOR DIFFERENT AIRPORT ALTERNATIVES
SAN MATEO COUNTY

	Alternative Airport Plans					Range	Probable
	1	4	8	9	10		
Population (000)	49.9	44.3	42.9	49.9	48.4	42.9 to 49.9	49.0
Dwelling Units (000)	16.3	14.6	14.1	16.3	15.9	14.1 to 16.3	16.1
Average Household Income $(000)	14.82	14.79	14.78	14.82	14.81	14.78 to 14.82	14.81
Aggregate Household Income $(millions)	267.50	237.71	220.67	266.83	259.56	229.67 to 267.50	264.00
Residential Land Acreage (000)	4.3	3.9	3.8	4.3	4.2	3.8 to 4.3	4.2
Non-residential Land Acreage (000)	.2	.1	.1	.2	.2	.1 to .2	.2
TAXES							
General Sales/Tax $(millions)	4.1	3.6	3.5	4.1	3.9	3.5 to 4.1	4.1
Federal Income $(millions)	87.9	77.9	75.2	87.6	85.3	75.2 to 87.9	87.3
State Income $(millions)	17.2	15.2	14.7	17.1	16.7	14.7 to 17.2	17.1
Property Tax $(millions)	17.2	15.7	15.2	17.6	17.1	15.2 to 17.7	17.5

Source: OP CIT

The results to be expected in 1985 cannot be forecast with complete accuracy, but the range secured from the I.T.T.E. report is reasonable and the weighted answer shown as probable in the table may be expected reasonably to occur.

It is anticipated that utilities will be concerned with increased demand for services. General estimates of new demand have been made for electricity, gas (for both heating and cooking), and water and sewerage needs. With the estimated "Probable" addition of 49,000 people who will need 16,100 dwelling units, as the result of the airport program, there will be the concomitant needs for utility expansion. Using factors developed

by P. G. &E. for San Mateo County for present conditions, it is estimated that in 1985 there will be a minimum of 81,546,000 KWH per year and 20,370 therms of gas required.

In addition, there will be the need for 6.4 millions of gallons of water per day. This is estimated from the current average usage in the area of 130 gallons per day per person. Based on the present factor of 90 percent, there will be 5.7 million gallons per day added to the sewerage system load.

These utility estimates represent about 8.8 percent growth over the 1970 demand and are based on 1970 capita utility consumption figures. These figures do not include any airport increased utility demands.

SECTION NINE

Section 9

ORGANIZATIONS CONTRIBUTING TO THE EIR

The bibliography lists many of the reports and consultants who prepared these reports either for RASS studies or under direct contract to San Francisco International Airport.

Bay Area Air Pollution Control District	Air Quality
R. W. Beck and Associates	Electrical Demand
Bolt, Beranek and Newman	Noise
Dygert and Ungerer	Airport Noise and Land Use
Gillfillan, Walter E.	Airport System Plan
Goldner	Airport Economic Effects
Metcalf and Eddy	Water, Sewerage, Drainage, Gas & Solid Waste Data
Wilbur Smith and Associates	Vehicular Traffic
R. Dixon Speas Associates	Airspace Capacity
Systems Analysis and Research Corp.	Aviation Forecasts
Wilsey and Ham	Physical Environment

The following organizations provided valuable data for the final report:

State Division of Highways
Association of Bay Area Governments
Metropolitan Transit Commission

The San Francisco International Airport staff and Bechtel Incorporated compiled and edited the reports.

SECTION TEN

Section 10

WATER QUALITY ASPECTS

No previous airport expansion projects have been certified as being in substantial compliance with applicable water quality standards. Certification is required for new water projects begun after April 16, 1973.

SECTION ELEVEN

Section 11

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APPENDIX A

APPENDIX A

INDIVIDUAL PROJECT DESCRIPTIONS WITH ENVIRONMENTAL IMPACT SYNOPSES

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
	TERMINAL AREA PROJECTS — PHASE I	
	North Terminal Complex	
T1	Demolition of Cargo Buildings 1, 2, 3, and 4 Demolition of existing cargo buildings located in the area in which the North Terminal facilities are to be constructed. Cargo Building 1 has been demolished; Cargo Buildings 2, 3, and 4 to be demolished according to the construction requirements of Boarding Area H and I and adjacent aprons. (25 percent complete — $300,000)	No significant impact. Will help provide an improved visual effect.
T2	North Terminal Foundations Construction of the 160,000-sq-ft basement structure, including first-level slab, for the foundation for the North Terminal, with utilities roughed in but excluding any finish work. (49 percent complete — $4,000,000)	No significant impact.
	South Terminal Complex	
T10	Boarding Area A Construction of the 200-foot-diameter, three-level rotunda structure, partially enclosed at ground	Will provide for larger and quieter aircraft and improved visual effect.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T10 cont.	level and fully enclosed at the second and third levels, finished in the public use areas, and including the first bay of the connector, and providing over 74,000 sq ft of enclosed space, with nonpublic areas completed to the extent prescribed by Airport Tenant Policy. Cogs have been added on the second level to meet airline requirements. (65 percent complete — $4,450,000)	
Ground Transportation Complex		
T26	Fifth-Level Addition to Existing Garage Construction of the 248,000-sq-ft fifth level on the existing terminal garage, providing about 600 additional parking spaces. (Complete — $1,967,305)	Improved capacity.
Ground Transportation Support Facilities		
T36	Entry Roads Including West Underpass Construction of new main entry roads and side service roads from Bayshore to the entrance to the terminal area, including construction of the West Underpass structure and a sewage lift station, and provision of utilities. (Complete — $3,008,025)	Improved capacity.
T37	Terminal Roads and East Underpass Construction of the two elevated three-lane roadways, the inner roadway running around the garage (except for the section in front of the garage) and the outer roadway consisting of an up-ramp to the South Terminal addition, replacement of the section between the South and	Improved capacity.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
	East Terminals, and extension from the East Terminal past the projected North Terminal to and including the down-ramp; construction of the new East Underpass, paving of the lower terminal roads, and construction of six sewage lift stations, four pedestrian tunnel structures and pedestrian bridge foundations, and provision of utilities. (Complete — $10,904,219)	

AIRSIDE AREA PROJECTS — PHASE I

A1	Taxiway B and Apron Reconstruction of Taxiways B and A by moving out 100 feet between Taxiways M and D to provide additional apron required to accommodate the new generation of large jets. (Complete — $2,755,238)	Provides facilities for larger and quieter aircraft.
A2	Extension of Taxiway B and Apron Extension of the new Taxiway B (A1) west from Taxiway D to provide additional clearance for 747 aircraft to pass at United's existing Pier b. (Complete — $1,022,119)	Provides facilities for larger and quieter aircraft.
A3	Taxiways G and L Construction of Taxiway G and extension of Taxiway L to the south from G, providing a bypass taxiway to Runway 1R to eliminate congestion on Taxiway B. (Complete — $625,679)	Eases congestion. Decreases air pollution because of less idling time.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
A4	South Terminal Apron Addition Extension of the apron to the South Terminal to provide aircraft parking and circulation area to accommodate Boarding Area A. (Complete — $880,963)	Provides facilities for larger and quieter aircraft.
A5	Boarding Area A Apron Reconstruction of the apron around Boarding Area A, because of the new location and design of the structure, to provide adequate pavement and drainage. (Complete — $589,731)	No significant impact.
A6	Taxiway D, E, F, and G Lighting Installation of taxiway centerline lighting in accordance with new criteria established by the FAA. (Complete — $225,182)	Increased safety.
A7	Centerline Taxiway B Lighting Installation of centerline lighting on the new Taxiway B in accordance with new FAA criteria. (Complete — $148,777)	Increased safety.
A8	Remote Transmitter Facility Relocation of the air-traffic control remote transmitters off Plot 40 to a new location at the north end of Taxiway P. (Complete — $103,990)	No significant impact.

LANDSIDE AREA PROJECTS — PHASE I

Landside Facilities

L1	Cargo Building No. 7 Construction of Cargo Building No. 7 to accommodate the	Improves visual effect over buildings that were demolished.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
L1 (Cont'd)	increasing demand for cargo space by the airlines and to provide replacement space for Cargo Building No. 1, demolished for construction of the North Terminal. (Complete — $386,880)	
L2	North Airport Fill Fill at the northern limit of airport land to provide approximately 60 acres of additional property for the expansion of cargo facilities and for airport facilities such as the airport water quality control plant. (Complete — $2,464,384)	No significant impact.
L3	West of Bayshore Fill Fill west of PG&E transmission lines on West of Bayshore property to begin preparing approximately 50 acres of airport land for construction of airport support facilities, such as airlines commissaries, rental car service, and parking. (Complete — $1,804,824)	Eliminates a low swampy area which was a potential mosquito breeding area.
Airport Service Facilities		
L8	West of Bayshore Power Substation Construction of a power substation, located west of Bayshore and south of the San Bruno interchange, to provide additional power for the airport and also to serve as a backup major power service to the main airport substation located adjacent to the airport entrance. (Complete — $357,079)	No significant impact.
L9	Sewage Treatment Plant Construction of a new 2.2 mgd secondary sewage treatment plant north of the seaplane	Provides increased capacity and improves effluent quality discharge.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
L9 (Cont'd)	harbor to meet new effluent quality standards and to prepare for the expansion of the airport. (Complete — $2,410,087)	
L10	Influent and Effluent Lines to Sewage Plant Extension of sewage pipelines to the new sewage plant and construction of a new effluent line to discharge offshore from the seaplane harbor. (Complete — $459,505)	Improves sewage treatment process.
L11	Utilities to Sewage Plant Provision of power, water, and telephone utilities to the new sewage treatment plant. (Complete — $232,715)	Improves sewage treatment process.

TERMINAL AREA PROJECTS — PHASE II

North Terminal Complex

T3	North Terminal Structure Completion of the North Terminal, including: • Extension of east end of basement under frontal gates between Frame 110 and 120 and column lines A.3 and F; extension of basement at west end between Frames 91 and 90 and column lines E and F, and between Frames 90 and 86 and column lines A.3 and F. • Construction of the complete superstructure from Frame 86 to Frame 120 including first level other than slab, second and third levels, canopy, and roof designed for parking, and	Will provide for larger aircraft, more passengers, and an aesthetically pleasing visual effect.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T3 (Cont'd)	finishing all public use areas, including two Superstair Complexes, and completion of rental areas in accordance with Airport Tenant Policy. • Construction of two pedestrian bridges connecting Superstair Complexes to the garage, with structural provision for People Mover System. • Finishing of basement constructed in Project T2. • Finishing of two pedestrian tunnels (constructed in Project T37) connecting the Superstair Complexes to the garage. • Construction of service road on a structural slab beneath the frontal gate holding rooms along the full length of the North Terminal. • Construction of a sidewalk-canopy structure, with crawl space below lower sidewalk, from Frame 120 to the East Terminal Building. • Construction and finishing of the sidewalk structures along the upper and lower terminal roads along the main North Terminal building from Frame 86 to Frame 120. (Budget — $28,000,000)	
T4	Boarding Area H and I and Connector Construction of a second-level satellite boarding area with a mezzanine area and partially enclosed ground floor level, providing approximately 272,000 sq ft of enclosed area, finished in public use areas and completed in rental areas	Will provide for larger aircraft, more passengers, and an aesthetically pleasing visual effect.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T4 (Cont'd)	in accordance with Airport Tenant Policy; including a 520-sq-ft-long second-level connector to the North Terminal with structural provisions for a People Mover System. (Budget — $19, 100, 000)	
T5	Boarding Area G and Connector Construction of a second-level satellite boarding area providing approximately 29, 000 sq ft of enclosed space with public use areas finished, rental areas completed in accordance with Airport Tenant Policy, and utilities stubbed for ground-level facilities to be constructed by tenant; including a 400-ft-long, second-level connector for the North Terminal with structural provision for a People Mover System. (Budget — $4, 300, 000)	Will provide for larger aircraft, more passengers, and an aesthetically pleasing visual effect.
East Terminal Complex		
T6	East Terminal Additions and Modifications Additions to and remodeling of the East Terminal Building, including: • Addition of frontal gates on field side to match new construction and minor remodeling of exterior. • Construction of pedestrian bridge connecting the East Terminal Superstair Complex with the Ground Transportation Complex, with structural provision for the People Mover System. • Create a Superstair Complex, including necessary structural alterations to receive the pedestrian bridge from the Ground Transportation Complex and provision for a People Mover Station.	May require some passenger inconveniences during remodeling.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
T6 (Cont'd)	• Remodeling of existing pedestrian tunnel to the Ground Transportation Complex. • General remodeling of first, second, and third levels to new terminal standards and Airport Lease Policy, but excluding any structural alterations for airline automated baggage handling equipment. • Demolition of existing control tower and necessary refinishing of areas disturbed. • Service road connection between northeast and southeast frontal gates. (Budget — $12,800,000)	
T7	Northeast Frontal Gates Construction of frontal gates between the East Terminal and the North Terminal consisting of second-level frontal gate holding rooms and concourse, with a service road beneath frontal gate holding rooms on a structural slab. (Budget — $2,500,000)	Will provide an improved visual effect.
T8	Southeast Frontal Gates Construction of frontal gates between the East Terminal and the South Terminal east addition, consisting of second-level frontal gate holding rooms and concourse, with a service road on a structural slab beneath frontal gate holding rooms. (Budget — $2,700,000)	Will provide an improved visual effect.
T9	Boarding Area E-F and Connector Construction of a second-level central concourse and two second-level satellite boarding areas, providing approximately 67,00 sq ft of enclosed space, with 100-ft-long	Will provide for larger and quieter aircraft and an improved visual effect.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
T9 (Cont'd)	connecting corridors between the boarding area and the main concourse, and a 400-ft-long, second-level connector to the East Terminal; including finish of public use areas, completion of rental areas in accordance with Airport Lease Policy, stubbing utilities to ground-level facilities to be constructed by tenants, and structural provisions for a People Mover System on the new connector. (Budget — $7,500,000)	

South Terminal Complex

T11	South Terminal West Addition Extension of South Terminal building from the existing wall (Frame 280) westward to Frame 270, providing a Superstair Complex for Boarding Area A and an additional 63,000 sq ft of public use and rentable space for the international airlines and concessionaires. Project includes: • Construction of full basement from grid lines B to F, a ground, second, and third level, a canopy and a roof designed as a parking area but not finished, with public use areas finished and rental areas completed in accordance with Airport Leasing Policy. • Construction of a pedestrian bridge connecting Boarding Area A Superstair Complex with the Ground Transportation Center, with structural provisions for the People Mover System. • Completion of the pedestrian tunnel (constructed in Project T37) connecting the above Superstair Complex to the Ground Transportation Center.	Will provide an improved visual effect.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
T11 (Cont'd)	• Construction of sidewalk structure between terminal and terminal roads at upper and lower levels for the entire length of the extension. (Budget — $9,200,000)	
T12	South Terminal East Addition Extension of South Terminal building from existing east wall (Frame 321) eastward to Frame 327 to provide for Superstair Complex for Boarding Area D, including: • Construction of full basement, from grid lines B to F, ground, second, and third levels, canopy and roof designed as parking area, with public use areas finished and rental areas completed in accordance with Airport Lease Policy. • Construction of a pedestrian bridge connecting the Boarding Area D Superstair Complex with the Ground Transportation Center, with structural provision for the People Mover System. • Completion of the pedestrian tunnel (constructed in Project T37) connecting the above Superstair Complex to the Ground Transportation Center. • Construction of a sidewalk-canopy structure with crawl space below lower sidewalk from Frame 327 to East Terminal building. • Making minor changes in South Terminal to accommodate connection of Superstair. • Construction of sidewalk structure and finish between terminal and terminal roads at upper and lower levels for the length of the extension. (Budget — $6,300,000)	Will provide an improved visual effect.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T13	South Terminal Additions and Frontal Gates • Construction and finishing of basement, first, second, and third levels; and roof additions at west and east ends between column lines D and E, to Frames 280 and 321, respectively. • Construction of basement area between column lines D and F in Frames 310 to 321 and 291 and 280. • Construction and finishing of frontal gate holding rooms and frontal gates at second level between Frames 298 to 280 and Frames 303 to 321. • Construction of service road on a structural slab beneath the frontal gate holding rooms along the full length of the South Terminal. (Budget — $8,500,000)	Will provide an improved visual effect.
T14	South Terminal Modifications Remodeling of the interior of the South Terminal, including: • Construction and finishing of the Boarding Area B-C Super-stair Complex, including necessary structural alterations to receive the pedestrian bridge from the Ground Transportation Center and provision for a People Mover System station. • Remodeling of the existing pedestrian tunnel to the garage structure. • Conversion of space vacated by steam plant to operations or rental areas.	May require some passenger inconveniences during remodeling.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T14 (Cont'd)	• General remodeling of finish and mechanical and electrical work to new terminal standards and Airport Tenant Policy, but excluding any structural alterations necessary for airline automated baggage handling equipment. • Modification of facade to match North Terminal facade. (Budget — $10,700,000)	
T15	Connector A Construction and finish of a 480-ft-long second level connector from the South Terminal to Boarding Area A, including a separate international arrivals corridor and structural provisions for a People Mover System. (Budget — $2,300,000)	Will provide an improved visual effect for international travelers.
T16	Boarding Area B Construction of three-level building similar to Boarding Area A, plus a second-level concourse with frontal gates joining it to Connector B-C, all providing approximately 84,000 sq ft of enclosed space, with public use areas finished, rental areas completed in accordance with Airport Lease Policy, and utilities stubbed for ground-level facilities to be constructed by tenants. (Budget — $8,000,000)	Will provide facilities for larger and quieter aircraft.
T17	Connector B-C Construction and finishing of a 540-ft-long, second-level connector from the South Terminal to Boarding Area B-C, including structural provisions for a People Mover System and station. (Budget — $4,300,000)	No significant impact.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T18	Boarding Area D and Connector Construction of second-level satellite boarding area providing approximately 29,000 sq ft of enclosed space, with public use areas finished, rental areas completed in accordance with Airport Tenant Policy, and utilities stubbed for ground-level facilities to be constructed by tenants; including a 400-ft-long, second-level connector to the South Terminal, with structural provisions for a People Mover System. (Budget — $4,600,000)	Will provide for larger and quieter aircraft.
Terminal Support Facilities		
T19	Central Heating and Cooling Plant Remove steam plant from the South Terminal and install in the new garage structure with sufficient boilers to provide high-temperature hot water to heat entire Terminal Complex. Locate with the water heating plant a new water chilling plant of sufficient capacity to provide chilled water to air conditioning heat exchangers in each terminal. (Budget — $5,000,000)	No significant impact.
T20	Utility Distribution Installation of utility mains from central supply facilities to the Terminal Complex facilities. (Budget — $1,000,000)	No significant impact.
T21	Interline Baggage Tunnel Provision of perimeter baggage/utility tunnel below first-level slab of garage addition and existing garage to permit passage of	Will provide means to reduce the number of baggage cart trams required on the apron.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T21 (Cont'd)	utility distribution mains from the central supply facilities and to provide for possible future installation of an interline baggage system. (Budget — $2,800,000)	
T22	People Mover System (Terminal) Purchase of the equipment for the horizontal elevator concept presently envisioned; installation of track and controls plus attendant escalators or vertical elevators required for the routes between the Terminal Buildings and the various Boarding Areas. (Budget — $7,800,000)	Will provide for more convenience to the traveling public.
T23	Terminal Furniture Allowance for furniture and furnishings for public use areas in all newly finished and remodeled terminal facilities. (Budget — $500,000)	Will provide more pleasing and comfortable public areas for passengers and visitors to the airport.
T24	Art Requirements An allowance to provide for work found necessary to comply with City Charter in regard to art enrichment. (Budget — $2,000,000)	Will provide an improved aesthetic effect.
T25	Demolition of Piers b, c, d, e, ff, and g Demolition of piers that are to be replaced by new construction in the Proposed Expansion Program. (Budget — $1,250,000)	Will provide an improved visual effect.
Ground Transportation Complex		
T27	Existing Garage — Modifications Implementation of necessary modifications to the existing garage structure to accommodate the	Will provide for improved passenger circulation.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
T27 (Cont'd)	addition of the new structure and to integrate the vertical transportation cores with the revised passenger transportation concept, including modifications of the existing foundations, demolition of the two existing vertical pedestrian transportation cores and replacement with three new stair and elevator cores, removal of existing automobile ramps, removal of existing exterior screen and replacement with balustrade facade to match new addition, and additional structural modifications as necessary to accommodate the remodeling, and the sixth-level Passenger Distribution Center additions. (Budget — $5,600,000)	
T28	Existing Garage — PMS Structure Provision of increased strength in the existing garage structure to permit installation of People Mover Systems and stations on the three radial lines serving the South Terminal and Boarding Areas B-C, Boarding Area D, and the East Terminal and Boarding Areas E-F. (Budget — $3,600,000)	May require some passenger inconvenience during construction.
T29	Garage Addition — Structure Construction of a five-level addition to the existing garage, increasing the parking capacity by about 4,300 to a total of 7,300 cars, including: • Construction of two automobile ramps for vertical circulation between all levels. • Creation of a 200-ft central open space with a landscaped plaza around the control tower column at the first level.	Will provide increased automobile capacity. Will have a small effect on internal vehicle traffic. Will have a visual effect because this is the structure directly ahead as an automobile passenger travels toward the terminal along the main entrance road.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
	• Installation of parking and traffic monitoring and control system to assure maximum utilization of parking facilities. • Construction of four vertical transportation cores. (Budget — $28,000,000)	
T30	Garage Addition — PMS Structure Provision of support structure in the garage addition for People Mover Systems and stations on the three radials serving the North Terminal and Boarding Area H-I, Boarding Area G, and Boarding Area A. (Budget — $500,000)	No significant impact.
T31	Passenger Distribution Center Construction at the sixth level of a Passenger Distribution Center structure including supports to facilitate access to the six radial access bridges to the various terminal buildings including finishing of all public areas and installation of PMS stations. (Budget — $8,100,000)	Will have a visual effect as automobile passengers travel toward the passenger terminal.
T32	Control Tower and Ring Construction of a nominal 200-ft-high column to support FAA-supplied control tower, plus concession space, observation platform, and FAA facilities located immediately beneath the control tower cab. (Budget — $3,800,000)	Will have a visual effect because this will become the tallest structure on the airport. Preliminary schematics indicate it will be aesthetically pleasing.
T33	Northest Court Parking Deck Provides for construction of temporary second-level parking structure in the present Northeast court, providing approximately 40,000 sq ft of parking space for short-term terminal parking. (Budget — $700,000)	Will make short-term parking convenient for airport visitors.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T34	Southeast Court Parking Deck Provides an identical facility as in T33 except in Southeast Court. (Budget — $600,000)	Will make short-term parking convenient for airport visitors.
T35	Rental Car Facilities Construction of multilevel parking, service, and administrative facilities for car rental agencies; all located on present Parking Lot A on the south side of the entrance road, with administrative areas finished in accordance with Airport Tenant Policy. (Budget — $5,000,000)	Will have a visual effect because this structure is on the south side of the entrance road and will provide more convenience for visitors to the city.
Ground Transportation Support Facilities		
T38	Upper Loop Road Section Completion of the final segment of of the inner loop of the upper terminal roads across the west side of the Ground Transportation Center, including piling for the final link of the lower road structures beneath. (Budget — $900,000)	Will provide improved automobile circulation.
T39	BART Access Structural provisions in foundations of garage addition to permit future construction of BART line and station below first level. (Budget — $2,000,000)	Will aid substantially in reducing the airport passengers' dependence on the automobile.
T40	People Mover System (Garage) Purchase of the equipment for the horizontal elevator concept presently envisioned and installation of track and controls plus attendant moving walks, escalators, or vertical elevators required for the routes between the terminals and the Ground Transportation Center. (Budget — $14,500,000)	Will provide for more convenience to the traveling public.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
T41	Road Graphics Provision of all location and direction signs on entry and terminal roads. (Budget — $600,000)	Will provide an improved visual effect.
T42	Grading, Irrigation, and Planting Provides for beautification by selected planting of entrance and exit ways from Bayshore Freeway to and around terminal complex. (Budget — $850,000)	Will provide an improved visual effect.

AIRSIDE AREA PROJECTS — PHASE II

*A9	Runway 1L — Extension Extension of Runway 1L approximately 750 ft at its south end to develop sufficient runway to accommodate larger aircraft on departure. (Budget — $230,000)	Will provide for more aircraft takeoffs over the Bay. Construction is to upgrade an existing taxiway to a runway. Runway threshold for landing on 1L will remain the same. Since some aircraft inadvertently use this taxiway as a part of the runway for takeoff, changing to a legal takeoff status is not considered a significant runway extension.
A10	Runway 19L Hi-Speed Exit Provision of a high-speed exit near the south end of Runway 19L to increase its landing acceptance rate and to eliminate interference with the instrument landing system caused by aircraft just landed. (Budget — $600,000)	Will decrease taxi time and air and noise pollution.
A11	Runway Drains 19R and 19L Provision of pump stations and discharge lines to pump drainage water from Runway 19R and 19L into the Bay, as for Project A14. (Budget — $500,000)	Projects A-11 and A-14 provide for pump stations and discharge lines to pump drainage water from between runways 19R and L and 28R and L into the Bay, replacing the present gravity system which has proved inadequate at high

*This project recommended for deletion.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
A11		tides. These pump lines discharge into the bay at the same point as the gravity lines. The major effect is to allow storm water to drain into the Bay at high tides as well as low tides. This is beneficial in that any storm water turbidity is diluted more by going into the Bay at all tides instead of just only at low tides. This is an item to increase the safety of airplane operations.
A12	Complete Runway 28R, including accompanying taxiway completion of Runway 28R by extending it approximately 2,500 ft to the east, to the same limit as Runway 28L, developing it for a Category 3A classification which will provide for the lowest landing weather minimums. (Budget — $2,900,000)	A separate impact statement has been filed on this project.
A13	Runway 28R — Hi-Speed Exit Provision of a high-speed exit taxiway from the extended Runway 28R to increase the runway landing acceptance rate. (Budget — $550,000)	Will decrease taxi time and air and noise pollution.
A14	Runway Drains 28R and 28L Provision of pump stations and discharge lines to pump drainage water from Runway 28R and 28L into the Bay, replacing the present gravity drainage system, which has proved inadequate during high tides. (Budget — $500,000)	See A11
A15	Extended Taxiways A and B to 10R Extension of Taxiways A and B to the western limit of Runway 10R to improve taxiway circulation and permit use of full length of the runway. (Budget — $1,500,000)	No significant impact.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
A16	North Terminal Aprons Provision of aprons for the new North Terminal building and Loading Facilities G, H, and I. (Budget — $4,000,000)	Will provide for larger and quieter aircraft.
A17	East Terminal Aprons Reconstruction of the aprons along the Southeast, East, and Northeast Terminals to provide for the frontal gate positions and for the new Loading Facilities E and F. (Budget — $1,000,000)	Will provide for larger and quieter aircraft.
A18	South Terminal Aprons Reconstruction of the aprons along the South Terminal building to provide for the frontal gate positions and for the new Loading Facility D. (Budget — $1,000,000)	Will provide for larger and quieter aircraft.
A19	Boarding Area B Apron Reconstruction of the apron around new Loading Facility B to provide adequate pavement and drainage. (Budget — $2,120,000)	No significant effect.
*A20	Noise Monitoring Program Perform the required initial noise study and provide the necessary noise monitoring system in areas adjacent to the airport in accordance with State Law. (Budget — $500,000)	Will define more precisely noise-impacted areas.

LANDSIDE AREA PROJECTS — PHASE II

Landside Facilities

L4	West of Bayshore Utilities and Roads Provision of utilities and roads necessary for the development of the property prepared as a result of the West of Bayshore Fill (Project L3). (Budget — $1,300,000)	No significant impact.

*Modification recommended to include Air Pollution Monitoring

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
L5	Seaplane Harbor Rough Fill Fill of the Seaplane Harbor to create property for cargo, airline maintenance, and airport operational requirements. (Budget — $10,000,000)	A separate impact statement is to be filed on this project, together with L6 because this involves filling a small portion of the Bay.
L6	Seaplane Harbor Roads and Utilities Provision of roads and utilities on the land created under Project L5 above to permit development of the property. (Budget — $2,500,000)	See Project L5.
L7	Relocation of Standard Oil Hangar Construction of a new hangar on Plot 18 adjacent to the Seaplane Harbor to be occupied by Standard Oil in trade for their current hangar adjacent to Cargo Building No. 7; and conversion of the existing hangar for cargo purposes to accommodate those displaced from demolished Cargo Buildings Nos. 2 and 3. (Budget — $900,000)	No significant impact
Airport Service Facilities		
L12	Stand-by Power, Sewage Plant Provision of a 500-kva stand-by power generation unit at the Sewage Treatment Plant with capacity to run the plant in the event of outage of the usual power supply and prevent by-passing; in conformance with Federal requirements. (Budget — $525,000)	Will provide safety features to ensure that sewage treatment plant operates during power failures.
L13	Deep Water Outfall, Sanitary Construction of an effluent link from the sewage plant to a deep-water sanitary outfall to be shared with the South San Francisco/San Bruno Sewage Treatment Plant, including the airport's share of the cost of the extension of their existing outfall to 5,000-ft lengths; in conformance with Federal requirements. (Budget — $500,000)	A separate impact statement has been filed on this project by the City of South San Francisco.

	PROJECT DESCRIPTION	ENVIRONMENTAL IMPACT SYNOPSIS
L14	Replace Present Sanitary Sewers Replacement of present sanitary sewers to increase capacity and to provide the greater pressure strength necessary to feed to influent line of the new sewage treatment plant. (Budget — $700,000)	Will provide for a more efficient sewage treatment process.
L15	Industrial Waste Plant Construction of a water treatment plant in the north airport fill area to treat industrial wastewater from aircraft washing bays, apron, and similar areas. Designed to produce an effluent meeting standards of the water quality control board. (Budget — $2,500,000)	Will improve the quality of wastewater entering the Bay. The exact amount of improvement cannot yet be quantified, but the plant will be designed to meet 1985 water quality discharge standards.
L16	Industrial Waste — Force Mains Construction of pressure pipelines required to convey wastewater from catch basins to the industrial waste treatment plant. (Budget — $1,000,000)	See Project L15.
L17	Industrial Waste — Pump Station Construction of pump stations required to pump industrial waste from catch basins to the industrial waste treatment plant. (Budget — $500,000)	See Project L15.
L18	Administration Building Construction of a multistoried facility on Lot B, with exterior appearance matching Rental Car Facilities on opposite side of entrance road. Top floor for Airport Administration, other floors for employee parking, with option of Maintenance Facility on portion of bottom two floors. (Budget — $5,000,000)	Will have a visual effect because this structure is on the north side of the entrance road.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
L19	Automatic Control Equipment Control systems for sensing and automatically reporting to a central control room conditions of security, fire control systems, communications systems, traffic, parking, vertical transportation systems, utility and environmental systems, noise abatement, and airfield and road lighting. Provides more efficient operations with less manpower. (Budget—$5,000,000)	No significant effect.
L20	Airport Maintenance Facility Consolidating maintenance facilities into a complete complex providing shops, control center, vehicle maintenance facility, centralized supply, corporation yard, lunchroom, washroom, and locker facilities with employee parking. (Budger—$1,500,000)	Will permit demolition of existing facilities and will improve visual appearance.
L21	Fire-Crash Building Expansion of No. 1 Crash House to accommodate additional equipment and manpower. (Budget—$500,000)	Is a required safety item. No significant impact.
L22	North Access Road Construction of a new road to service the new property created by the North Airport Fill (Project L2). (Budget—$230,000)	Will provide increased vehicular access.
*L23	Increase Frontage Roads to Four Lanes Reconstruction of the frontage roads between Milbrae Avenue and San Bruno Avenue to increase capacity to four lanes throughout. (Budget — $2,500,000)	Will increase vehicular capacity.

*Modification of project scope recommended to provide for jointly sponsored improvements to intersections of Frontage Road with Millbrae Avenue and San Bruno Avenue.

PROJECT DESCRIPTION		ENVIRONMENTAL IMPACT SYNOPSIS
L24	Overpass to West of Bayshore Property Construction of an overpass to connect the West of Bayshore property directly with the main airport area, to be located just south of the Bayshore Airport interchange, and connecting to Road R-2 immediately south of Hilton Hotel. (To be financed and constructed by California Highway Commission.)	Will provide increased vehicular access.

APPENDIX B

APPENDIX B

SYNOPSIS OF PUBLIC HEARINGS CONDUCTED BY THE REGIONAL AIRPORT SYSTEM STUDY COMMITTEE

The purpose of these hearings was to receive from agencies and the public response to the technical material prepared to date, to allow additional information to be added to the record, and to receive an insight into opinions and concerns about present and future aviation development in the region.

The Regional Airport Systems Study Committee (RASSC) had originally scheduled three public hearings in the Bay Area — North, Central, and South Bay. In response to requests from San Francisco and Marin counties, two additional hearings were added. The following is a summary of these hearings:

Fairfield — November 15, 1971

Speakers included local city and county officials, and representatives from an airport, an airport land use commission, a public works department, an industrial development agency, Travis Air Force Base, and the State Department of Aeronautics. Approximately 80 people attended.

Most speakers favored development of northern Bay airports as part of a regional airport system because of land available and favorable location for handling growth. For Solano County, it was suggested that there would be a tolerance of airports because of the community's acceptance of Travis. A Travis/Meridian Airport was advocated, with civilian operations on a runway parallel to the existing runway and use of Travis' air traffic control tower. A representative of the Base Commander at Travis stated that although limited civilian use had begun, plans were that military use would not be phased out. Testimony also indicated opposition to any joint use that would interfere with the military mission.

Other suggestions to the RASSC were to consider general aviation needs and air freight and to hold an additional hearing at the recommendation stage of the study. No adverse environmental comments were received at this particular hearing.

Oakland — December 13, 1971

At this hearing, speakers included the Mayor of Oakland, a judge, and representatives from the California Public Utilities Commission, the President's Aviation Advisory Commission, California Department of Aeronautics, Port of Oakland, chambers of commerce/convention and tourism bureaus, citizens, industry groups, labor, League of Women Voters, conservation groups, an economic development agency, and a flower shipping company. There were approximately 100 attendees.

Many who testified advocated expansion of Oakland airport (and the corollary of using all airports to capacity), because such development would increase jobs, attract visitors, and improve service.

Others felt that demand should not automatically be met, that growth should should be restrained because of detrimental impact on environment, inflated population forecasts, and alternatives to growth, including increasing load factors, and improving ground transit and access.

A member of the President's Aviation Advisory Commission suggested that the RASSC consider the long-range needs of the aerospace transportation system, based on user demand, environmental impact, and economic impact on the nonflying public.

The Chairman of the California Public Utilities Commission recommended that use of the existing airports to capacity be encouraged (particularly San Jose and Oakland) and dispersal of services near the origin/destination

of passengers. The Civil Aeronautics Board should then consider the Study findings for allocating routes. He offered Commission interest and support in the evolution of the plan.

Recommendations from those who testified included: keep military bases separate, explore the use of STOL, have flight operations over water to reduce noise, include general aviation in the study, look at a total transportation system, hold another hearing before final recommendation, and provide for airport planning and implementation of study findings after the study is completed. There was negative response to filling the Bay, and to three proposed sites — Richmond, Site E near Alviso, and Buchanan Field, Concord.

San Jose — January 10, 1972

Nearly 300 people attended, with representatives giving testimony from Congressman Edwards, local mayors, city managers, and councilman, the Sierra Club, Save Our Valley Action Committee, chambers of commerce, League of Women Voters, a school district, airport committees, and industry, citizen, and conservation groups. Many individuals also spoke.

The opinion reiterated almost unanimously was opposition to Site E (Alviso-Fremont area), because of noise and air quality hazards, encroachment on the proposed National Wildlife Refuge Area and growth implications. Many speakers supported no further expansion of San Jose airport, while others recommended such expansion.

Several people again advised the Committee to integrate air travel with other modes of transportation; to revise population forecasts downward, to coordinate with the Metropolitan Transportation Commission; to hold another hearing after the recommendation was made; to consider a

regional airport away from urban areas, and to continue the study through an implementation phase.

There was great concern expressed over some implications of air travel/ airport development. It was felt that the needs of the air traveler should not take precedence over those of the rest of the population; that air travel demand was perhaps not as high a priority as other needs (e.g., housing); that there were serious medical effects due to noise and air pollution; and that citizens should exercise some control over the usage of airports. A question for the Committee to consider was who should control the number of flights — CAB, the airlines, the airport, or the passengers?

San Francisco — February 3, 1972

Speakers at this hearing represented the S.F. Airports Commission, Sierra Club, City of Alameda, League of Women Voters, S.F. Chamber of Commerce/Visitors and Convention Bureau, a community development corps, conservation groups, labor, Federal Aviation Administration, Air Transport Association, Bay Conservation and Development Commission, and San Francisco Planning and Urban Renewal Association. Approximately 200 people attended.

Opinion seemed to be divided between those speakers who favored expansion of all area airports (because of increased employment) to accommodate demand, and those who did not favor expansion, but instead higher load factors, fewer scheduled flights, revised forecasts, and dispersal of airports.

Recommendations were made to consider joint use of Hamilton, general aviation needs, long-term regional airport planning, distant new airport locations, converting military bases to recreation areas, coordination with MTC, and airports located near the origin and destination of passengers.

Again, the point was made to consider the majority of the public who do not fly.

Airport expansion involving Bay fill was opposed during testimony. The guideline stated by BCDC, the agency issuing permits for fill, is that if Bay fill is requested for airport expansion, the burden of proof is on the proponent.

San Rafael — February 18, 1972

Speakers were from San Benito, Marin, and Sonoma Counties, representing the Board of Supervisors of San Benito County, City of Hollister, Hollister Chamber of Commerce and Women's Club, City of Novato Planning Commission, Novato Neighborhood Planning Groups, two homeowners associations, Marin Alternative, and Sonoma County Airport.

Testimony from the Hollister area stated opposition to a regional airport in their community, because of the expansion it would bring to their rural area, severe air pollution potential, and earthquake hazards. Alternatives suggested were dispersal of services to small airports, and use of rapid transit.

Also considered was the joint civilian/military use of Hamilton Air Force Base. Most speakers opposed such use of Hamilton because it would seriously affect the noise and air pollution levels, property values, and rural nature of Marin County.

The Study Committee was requested to hold other public hearings prior to final adoption of a plan.

Many Marin citizens were concerned that impact of airports on their neighborhoods should be thoroughly evaluated before any recommendations

were made. An example of the community viewpoint was expressed by the representative of Marin Alternative: "Thank you, gentlemen for your professional views and studies. But in the final analysis it is we who want to determine the make-up of our communities and our regions."

APPENDIX C

Appendix C

QUESTIONNAIRE SURVEY RESULTS

To obtain the public's response to the development of airports in the area, the Association of Bay Area Governments (ABAG) distributed 30,000 copies of a newspaper, Aviation Future, containing a questionnaire in 1971 to:

Individuals	43%
Conservation/ecology groups	9%
League of Women Voters	9%
Chambers of Commerce	8%
Bay Area airports (13 airports)	13%
ABAG mailing lists	10%
Others	8%

Eight hundred and fifty-one people answered and returned the questionnaire contained in the newspaper, and also reprinted by Save Our Valley Action Committee, Novato Planning Committee, the Fremont Argus, and the Novato Advance. The questionnaire is shown on the following page. A summary of the responses is given in the following paragraphs.

It should be noted that the county of residence of the respondents did not provide a uniform sample of all communities in the Bay Area. A breakdown of the county of residence of respondents compared to population is as follows:

UNUSABLE

Wanted: Your Opinion

Your opinion can have influence even if you do not testify at the public hearings. Please help us reach the "best" recommendation for the Region by mailing us your completed questionnaire as soon as possible. Your written responses, in addition to answers to the following questions, are welcome.

1. In your opinion, should the Bay Area provide additional facilities in the future for air travel into and out of the Region?

27 — 305 (35%) Yes — 275 (22%) No — 244 (29%) I need to know more about the alternatives

2. What relative importance do you assign to the following (please rank from 1, most important to 5, least important).

   ______ Air travel availability and quality
   ______ Easy access to and from airports
   ______ Financial benefits of airports — (see below)
   ______ Financial costs of airports
   ______ Environmental effects of aviation

3. Would you vote for an airport development:
   If the development were in your part of the Region?

11 — 242 (28%) Yes — 465 (55%) No — 133 (16%) Undecided

   If the development were in some other part of the Region?

38 — 236 (28%) Yes — 288 (34%) No — 289 (34%) Undecided

4. As an airline passenger, how long a trip (in minutes) would be "reasonable" for you to travel to or from the airport?

48 — 18 (2%) 10 — 129 (15%) 20 — 343 (40%) 30 — 170 (20%) 40 — 143 (17%) 50 or more

5. If flight schedules were the *same* at these airports, which airport would you choose?

from home		*from work*	*from home*		*from work*
(17%) 147	San Francisco	130 (15%)	(38%) 319	San Jose	250 (29%)
(35%) 295	Oakland	273 (32%)	(2%) 16 (*where*)	other	21 (2%) (*where*)

73-home
178-work

6. If access time and cost were about the same for automobiles and rapid transit, which would you choose?

15 — 143 (17%) automobile — 652 (77%) rapid transit — 41 (5%) undecided

7. In what city do you live? (see below)
   In what city do you work? "

8. How many airline flights have you taken *out* of the Bay Area in the last year?

14 — 190 (22%) 0 — 265 (31%) 1-2 — 165 (19%) 3-4 — 217 (26%) 5 or more

9. Of the environmental issues listed below, how would you rank them in order of importance to you (from 1 most important to 6 least important)? (see below)

   ______ air quality ______ plant life
   ______ bay preservation ______ population level
   ______ noise ______ wild animal life

10. Please return to: Regional Airport Systems Study, Association of Bay Area Governments, Hotel Claremont, Berkeley, California 94705

County	Population (U.S. Census) 1970	Percent of Total Bay Area Population	Number of Responses to Questionnaire	Percent (by county) of Responses to Questionnaire
Alameda	1,073,000	23	213	25
Contra Costa	558,000	12	122	14
Marin	206,000	4	90	11
Napa	79,000	2	0	0
San Francisco	716,000	16	40	5
San Mateo	556,000	12	39	5
Santa Clara	1,065,000	23	323	38
Solano	170,000	4	8	1
Sonoma	205,000	4	8	1
TOTAL	4,628,000		851	

- Question 2 — What relative importance do you assign to the following (please rank from 1, most important to 5, least important).

	1	2	3	4	5	Unusable
Air travel availability and quality	191	216	174	129	89	52
Easy access to and from airports	119	214	215	152	100	51
Financial benefits of airports	22	63	168	201	333	64
Financial costs of airports	37	201	117	246	187	63
Environmental effects of aviation	486	97	113	48	74	33

- Question 5 — If flight schedules were the <u>same</u> at these airports, which airport would you choose?

Airport Preference from Home (No. of responses)	Airport	Airport Preference from Work (No. of responses)
295	Oakland	273
147	San Francisco	130
319	San Jose	250
5	Marin County	5
1	San Rafael	1
2	Contra Costa	1
1	Buchanan	1
2	Solano County	2
2	San Benito County	2
1	Mendocino County	-

Airport Preference from Home (No. of responses)	Airport	Airport Preference from Work (No. of responses)
1	Napa	1
1	Palo Alto	1
-	Fremont	1
-	Livermore	2
-	Walnut Creek	2
-	Hamilton	2
73	Unusable	178

- Question 9 — Of the environmental issues listed below, how would you rank them in order of importance to you (from 1, most important to 6, least important)?

	1	2	3	4	5	6	7	Unusable
Air quality	413	215	96	46	34	22	0	25
Bay preservation	105	172	195	187	92	68	2	30
Noise	163	182	164	97	89	136	0	20
Plant life	54	49	120	194	254	148	0	32
Population level	230	122	132	119	81	139	0	28
Wild animal life	56	64	85	139	219	254	0	34
Other	1	1	0	0	0	0	1	0

There are 157 additional comments, falling into the following categories: airport development (46), environment (43), access (22), other modes of transportation (10), questionnaire itself (8), RASS itself (6), improved airline service (5), personal relationship to aviation (7), and multiple comments (9).

COMMENTS AND COMPARISONS

- Questions 1 and 8 — providing additional facilities and number of flights in last year: Of the respondents who had flown one or more times out of the area, more favored additional facilities than did not. However, those who had not flown at all disapproved of additional facilities more often than they approved.
- Questions 3 and 8 — voting for nearby or distant airport development and number of flights: Most people responded that they did not favor either nearby or distant development, regardless of number of flights.

- Questions 4 and 6 — reasonable travel time and preference between automobile and rapid transit: The travel time chosen most often as reasonable by those who preferred either the automobile or rapid transit was 30 minutes.

  The travel times were ranked as follows:

  - Automobile: 30 minutes first, then 20, 40, 50, and 10 minutes
  - Rapid transit: 30 minutes first, then 40, 50, 20, and 10 minutes

- Questions 4 and 8 — reasonable travel time and frequency of flight: Whatever the frequency of flight, the preferred travel time was 30 minutes.

- Questions 1 and 3 — provide additional facilities and nearby/distant airport development: Of the responses possible, more responded "no" to providing facilities and "no" to voting for development — either nearby or distant.

  Desire for facilities and willingness to vote for airport development are correlated. The most frequent response was yes facilities/yes development.

- Questions 1 and 7a — providing facilities and county of residence: Of responses from Alameda, San Mateo, Santa Clara, and Sonoma Counties, more responded "no" to additional facilities than responded "yes." The reverse was true for Contra Costa, Marin, San Francisco, and Solano County respondents; more responded "yes" to additional facilities.

- Questions 5 and 8 — airport choices from home and work and number of flights (OAK=Oakland, SFO=San Francisco, SJC=San Jose).

  <u>From home</u>

  Those who have flown 3-4, or more than 5 times chose OAK, then SJC, then SFO. Those who have flown 0 or 1-2 times chose OAK, then SJC, then SFO.

  <u>From work</u>

  Those who have flown 0, 1-2, or 3-4 times chose OAK, then SJC, then SFO. Those who have flown more than 5 times chose SJC, then OAK, then SFO.

- Questions 5 and 7 — home and work airport choice, and county of residence and employment: Airport choices

from home and work when compared with county of residence and employment were so similar that they followed this pattern with only minor discrepancies;

County	Airport Choice (listed in order of ranking)
Alameda	OAK, SJC, SFO
Contra Costa	OAK, SFO, SJC
Marin	SFO, OAK
Napa	No response to questionnaire
San Francisco	SFO, OAK, SJC
San Mateo	SFO, SJC, OAK
Santa Clara	SJC, SFO, OAK
Solano	OAK, SFO
Sonoma	OAK, SFO

- Questions 6 and 8 — choice of automobile and rapid transit and frequency of flights: Of the people who chose rapid transit, the greatest number of responses came from those who had flown 1-2 times in the past year, while of those who chose automobiles, the greatest number of responses came from those who had flown more than 5 times. However, whatever the flight frequency, more people chose rapid transit than chose the automobile.
- Questions 7 and 8 — county of residence/employment and frequency of flight: The counties with a large sample — Alameda, Santa Clara, and Contra Costa — all followed this pattern of flight frequency; 1-2 flights/year most frequent, then more than 5, then 0, then 3-4 flights. (This applies to both county of residence and county of employment.)
- Compare the home and work airport choices stated in question 5 with the consultant work on Access done by Wilbur Smith, Phase I, June, 1970: (Airport Access).

  The Access report shows that for 1975, assuming unconstrained conditions, air passengers would be allocated as follows:

SFO	33%
OAK	44%
SJC	23%

The results of this questionnaire show that, of those who responded (note that there is a low response rate from Napa, San Francisco, San Mateo, Solano, and Sonoma Counties), and with unrestrained conditions, their choice of airports in 1972 would be as follows:

From Home		From Work	
SFO	17%	SFO	15%
OAK	35%	OAK	32%
SJC	38%	SJC	29%

APPENDIX D

Appendix D[1]

NOISE

Since the introduction of high-power military jet aircraft in the early 1950's and the widespread introduction of commercial jet aircraft in the early 1960's, considerable study has been devoted to the measurement of aircraft noise and the interpretation of aircraft noise with respect to its effect on people, both as individuals and as groups living in communities near airports. From these studies, various measures have evolved for relating the noise of single events, such as an aircraft flyover, to individual response, and various methods have been developed for estimating community response to the noise environment created by aircraft operations occurring over an extended period of time. Two types of noise descriptors are used in describing aircraft noise:

- Descriptors concerned with measurements of single events such as the noise generated by an aircraft takeoff, landing, or a ground runup operation. These are of practical interest in comparing one event with another, or in comparing the noise produced by different aircraft.

- Descriptors concerned with summarizing the noise exposure resulting from many individual noise events of different levels and time patterns occurring over a considerable time period. These are of particular interest in comparing the noise exposure existing at different positions around the airport, or in comparing the effect of changes in airport configurations or operations.

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[1] Most of this section is excerpted from Aviation Noise Evaluations and Projections, San Francisco Bay Region, Bolt Beranek and Newman, August 1971

Of major concern at San Francisco International Airport is the noise produced by jet aircraft during takeoff and landing operations.

As shown in Figure D-1, a typical flyover noise signal can be characterized in time as a "haystack" shaped signal that emerges from a lower ambient noise level and increases to a maximum over a period of seconds and then decreases to merge once more with the background noise. The flyover signal can be described in terms of either the maximum noise level reached during the flyover or in terms of the integration of the noise signal over time (i. e., include the effects of signal duration as well as maximum level).

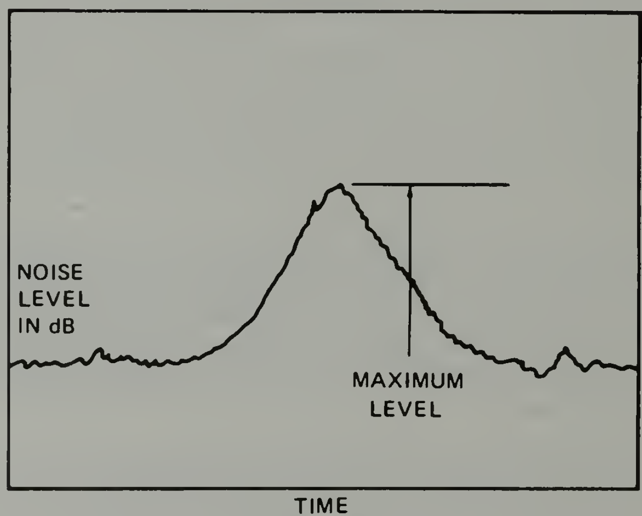

Figure D-1. Aircraft Noise Level Versus Time

Studies over the last few years have resulted in the development of several meaningful scales, of varying complexities and accuracy, for measuring aircraft noise. These studies were prompted by the fact that many direct and simple measurements of aircraft noise showed relatively poor correlation with people's subjective assessments of aircraft sounds. As an example, if one measures aircraft noise in terms of the overall sound pressure level using a sound level meter, one will find the same overall sound pressure level reading for a flyover by a jet aircraft and a piston-powered propeller aircraft. However, the jet aircraft would sound much noisier (or less acceptable) to the average observer than the flyover sound of a piston-powered propeller aircraft. The major reason for this discrepancy between measurement and human response is that the human ear does not respond equally well to sound of all frequencies but is less efficient at low and high frequencies than at medium or speech-range frequencies. Thus, to obtain a single number measure of the sound pressure level of a noise that may contain a wide range of frequencies in a manner approximating that of the ear, it is necessary to reduce, or weight, the low and high frequencies with respect to the medium frequencies.

Various noise exposure methods have been developed to describe the noise exposure resulting from repeated single events. All the procedures include some common elements that are vital in describing the noise impact in land areas surrounding an airport. These elements are:

- Evaluations of the noise level of individual events that are well correlated with people's response in terms of loudness, noisiness, or acceptability, or that can be related to speech interference effects.
- Adjustments for the relative duration of noise intrusions and the number of noise events occurring within a given time period.

- Weighting factors for daytime and nighttime (or daytime, evening, and night periods). Such weighting factors are particularly important in relating noise exposure to response in residential areas because of the increased sensitivity of people to noise intrusions during leisure and sleeping hours.

The effect of the adjustments and weighting factors is to expand the size of a given noise exposure contour as the noise levels increase, or as the number of operations increase, or as the proportion of night operations increase.

Currently three measures for describing the noise environment in the vicinity of airports are in use within the State of California. Listed in order of historical development, the three measures are:

- Composite Noise Rating (CNR)
- Noise Exposure Forecast (NEF)
- Community Noise Equivalent Level (CNEL)

The Noise Exposure Forecast procedures used in this report are a refinement of the earlier CNR procedures[2] widely used in this country by the FAA and Department of Defense for airport and land-use planning. The NEF procedures have been applied to define the noise exposure around a number of U. S. airports[3].

The CNEL is employed in the airport noise standards by the State of California and has been developed basically for noise surveillance to define noise impact areas around airports and to determine compliance with noise limits[4]. Table D-1 presents a summary comparison of the factors utilized in the three noise environment measures. The Bishop-Simpson report[3] gives further comparisons of NEF, CNR, and CNEL values to facilitate conversions from one measure to another.

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[2] Galloway, W. J., and Pietrasanta, A. C., Land Use Planning Relating to Aircraft Noise, Technical Report No. 821, Bolt Beranek and Newman Inc., published by the FAA, October 1964. Also published by the Department of Defense as AFM 86-5, TM 5-365, NAVDOCKS P-98, Land Use Planning with Respect to Aircraft Noise.

[3] Bishop, D. E., and Simpson, M. A., Noise Exposure Forecast Contours for 1967, 1970, and 1975 Operations at Selected Airports, FAA Report FAA-NO-70-8, 1970

[4] Section 21669 Public Utilities Code, State of California

Table D-1

COMPARISON OF FACTORS CONSIDERED IN NOISE ENVIRONMENT MEASURES

Noise Environment Measure	Basic Noise Measure	Adjustment For Number Of Operations	Weighting For Time Of Day
CNR	PNL[b]	10 log n (modified)[a]	Night Weighting
NEF	EPNL[c]	10 log n	Night Weighting
CNEL	SENEL[d]	10 log n	Evening And Night Weightings

[a]Employs adjustments in 5-unit steps.

[b]Perceived noise level.

[c]Effective perceived noise level.

[d]Single event noise exposure level.

The Noise Exposure Forecast (NEF) value at a ground position provides an estimate of the integrated noise exposure resulting from aircraft operations. The NEF values are calculated from:

- Measures of the aircraft flyover noise described in terms of the EPNL.

- The average number of flyovers per day (0700 to 2000 hours) and per night (2200 to 0700 hours).

In calculation, it is convenient to group the aircraft in classes by consideration of the aircraft noise characteristics and takeoff and landing performance. Each class is assigned a description of the noise in terms of a set of EPNL versus distance curves and a set of takeoff and landing profiles. Thus, for a given class of aircraft at a particular power setting (i.e., takeoff power), it is assumed that the aircraft noise characteristics can be described by a single EPNL-versus-distance curve.

The total noise exposure at a given point produced by aircraft operations is viewed as being composed of the effective perceived noise levels produced by the number of operations of each different aircraft class flying along different flight paths.

The civil aircraft noise and profile information utilized in the construction of the NEF contours is summarized in the Bishop-Simpson report[5]. Information is given for 12 major civil aircraft classes that include current and future commercial jet aircraft to 1985, with the exception of possible SST aircraft. Noise information for current aircraft is based on measurements from a variety of sources, and includes data from both formal aircraft noise tests and measurements at civil airports during routine airport operations.

Noise and performance projections for future aircraft are based on industry estimates and the assumption that by 1985 all types of older aircraft (in service in 1970-71) will have been modified to meet current (1971) FAA noise certification requirements for newer aircraft under Federal Aviation Regulation (FAR) 36.

FAA noise certification requirements[6] do not define specific aircraft performance and noise characteristics; thus, some arbitrary assumptions must be made as to the means by which aircraft will meet FAR 36 standards. For this study, it was assumed that takeoff and landing profiles

[5] Bishop and Simpson, op. cit.

[6] The FAR 36 standards set aircraft noise level limits at three positions for maximum gross-weight conditions and for a single set of "acoustic reference" weather conditions (77°F, relative humidity of 70 percent, and zero wind). The three positions are: (a) under the takeoff flight path at 3.5 nautical miles from start to takeoff roll; (b) to the side of takeoff path at 0.25 (or 0.35) nautical miles at the point of maximum noise level; (c) under the approach path, at 1 nautical mile from the runway threshold. The standards permit a power cutback before reaching the takeoff noise measurement position.

would be unchanged, with noise characteristics alone modified to meet FAR 36 requirements. It was further assumed that the modifications would be the minimum to meet FAR 36 requirements. While this is a conservative (i.e., pessimistic) assumption, it more realistically reflects what may happen with engine retrofit programs. It was therefore assumed that aircraft will meet FAR 36 takeoff requirements (3.5 nautical miles from start of takeoff roll) by a noise abatement procedure involving a reduction of thrust and in climb gradient before reaching the 3.5-nautical-mile point. However, since there is no requirement that such special noise abatement procedures be used in actual service, power cutback procedures and profiles were not assumed in computing the NEF contours for the San Francisco International Airport. If the cutback were utilized, a reduction of about 13 EPNdB (effective perceived noise decibels) would be effected for four-engine jet aircraft and significantly smaller NEF contours for takeoff flight paths would result.

Reductions of approach noise of approximately 6 to 11 EPNdB have been assumed to meet FAR 36 approach requirements, and a reduction of approximately 2 EPNdB in noise levels at takeoff thrust have been assumed to meet FAR 36 "sideline" requirements.

A heavily loaded "jumbo jet" aircraft will fly out at lower altitudes than the same aircraft lightly loaded. It will also fly out at a lower altitude than a fully loaded DC-8, but the noise will be less and the number of passengers carried will be greater.

The current number of passenger seats on an aircraft varies with each airline. The DC-10 has between 200 and 249 seats; and the 747 has between 300 and 350.

The DC-8-50 carries 127 passengers. The DC-10 can carry 1.6 to 2.0 times the number of passengers as a DC-8-50, and the 747 carries 2.4 to 2.7 times as many passengers. With the elimination of lounges, the capacity of the larger jets is more, up to 270 passengers on a DC-10, and 400 passengers on the 747. The takeoff profile for a full passenger load, $59^{\circ}F$, no wind, and a flight to Chicago for the following aircraft is as follows:

DC-10	Takeoff Weight — 360,000 Pounds	220 Passengers
	Distance from Start of Takeoff Feet	Height at Distance Feet
	5,000	35
	8,400	380
	18,700	2,000
747	Takeoff Weight — 550,000 Pounds	313 Passengers
	12,000	915
	16,000	1,490
	19,650	2,000
DC-8-50 (Fan)	Takeoff Weight — 220,000 Pounds	127 Passengers
	4,500	40
	7,000	360
	16,300	2,000

Plotting these still air takeoff profiles, the height and Single Event Noise Exposure Levels are calculated as follows:

	Distance from Start of Takeoff Roll Feet	Height above Sea Level at Distance, Feet	SENEL
DC-8	16,000	1,940	105
DC-10	16,000	1,600	98
B-747	16,000	1,490	102
DC-8	21,000	2,810	102
DC-10	21,000	2,340	94
B-747	21,000	2,200	98

This indicates that the larger jets when fully loaded are quieter than a fully loaded DC-8 and they carry more passengers. To carry the same number of annual passengers, the larger jets would make fewer landings and takeoffs. Fewer flights in quieter aircraft create less noise annoyance.

The estimates of the "total" noise exposure resulting from aircraft operations, expressed as NEF values, can be interpreted in terms of probable impact on land uses using the guides summarized in this section of the report. These guides[7] are based on the following major considerations.

- Accumulated case history experiences of noise complaints near civil and military airports
- Speech interference criteria

[7] Adopted from: Galloway, W. J., and Bishop, D. E., Noise Exposure Forecasts: Evolution, Evaluation, Extensions and Land Use Interpretations, FAA-NO-70-9, 1970

- Subjective judgment tests of noise acceptability and relative "noisiness"
- Need for freedom from noise intrusions
- Typical noise insulation provided by common types of building construction

Different considerations are given precedence for the differing land uses. For example, in determining the effects of noise on residential land use, case history experience, annoyance judgments, and speech communication criteria are most important; for concert halls, the need for freedom from noise intrusion is probably most important.

Table D-2 presents the interpretations of land use compatibility with respect to NEF values for generalized land uses — residential and educational, commercial, industrial, and agricultural (or open). In Table D-2, the compatibility interpretation for the lowest NEF values has the notation "satisfactory, with... no special noise insulation requirements for new construction", indicating that there should be no adverse effects from aircraft noise. The interpretations at higher levels of noise exposure generally define a range in which new construction or development should not be undertaken unless needed noise insulation features are included in the building design and site development. For more extreme noise exposure, many of the land uses are assigned an interpretation stating new construction or development should not be undertaken.

Each of the four generalized land uses encompasses a rather wide range of human activities having varying sensitivities to noise intrusions. Hence, the interpretations of Table D-2 should be taken as guides, not as absolute criteria to be blindly applied to all activities or sites falling into one of the classifications. In application to a specific site, some

Table D-2

NOISE COMPATIBILITY INTERPRETATION

Generalized Land Use	NEF Range	General Land Use Recommendation
Residential and Educational	Less than 30	Satisfactory, with little noise impact and requiring no special noise insulation requirements for new construction.
	30 to 35	New construction or development should be undertaken only after an analysis of noise reduction requirements is made and needed noise insulation features included in the design.
	Greater than 35	New construction or development should not be undertaken.
Commercial	Less than 35	Satisfactory, with little noise impact and requiring no special noise insulation requirements for new construction.
	35 to 45	New construction or development should be undertaken only after an analysis of noise reduction requirements is made and needed noise insulation features included in the design.
	Greater than 45	New construction or development should not be undertaken unless related to airport activities or services. Conventional construction will generally be inadequate and special noise insulation features should be included in construction.
Industrial	Less than 40	Satisfactory, with little noise impact and requiring no special noise insulation requirements for new construction.
	40 to 50	New construction or development should be undertaken only after an analysis of noise reduction requirements is made and needed noise insulation features included in the design.
Generalized Land Use	NEF Range	General Land Use Recommendation
	Greater than 50	New construction or development should not be undertaken unless related to airport activities or services. Conventional construction will generally be inadequate and special noise insulation features should be included in construction.
Open	Less than 40	Satisfactory, with little noise impact and requiring no special noise insulation requirements for new construction.
	Greater than 40	Land uses involving concentrations of people (spectator sports and some recreational facilities) or of animals (livestock farming and animal breeding) should generally be avoided.

Source: Bolt, Beranek and Newman, Aviation Noise Evaluations and Projections, San Francisco Bay Region, August 1971.

adjustments in boundaries or interpretations may be desirable. Typical influences to consider include:

- Previous community experience and previous complaint history in the immediate neighborhood
- Influence of the existing noise environment due to industrial or surface transportation noise sources. For example, the introduction of aircraft noise in a rural area where existing background noise levels are very low would produce a much more apparent change in noise environment, and likely more pronounced reaction from residents, than would aircraft noise introduced in a dense urban area long exposed to traffic noise
- Time period of land-use activities. The basic NEF values consider both daytime and nighttime operations, with a heavy weighting factor applied for nighttime operation. Such considerations are particularly appropriate for residential land considerations but may lead to overestimation of NEF values for activities that are confined to daytime hours only.

The NEF values for land-use compatibility in Table D-2 are based on the type of building construction that would normally be used where aircraft noise is of no concern. Thus, the land-use compatibility ratings for schools assume building construction involving single glazing of classroom windows. Special noise consideration incorporating double glazing or elimination of windows entirely has not been made. Obviously, for many buildings, added noise insulation can be provided during construction. Procedures and data for determining the degree of noise insulation and the specific construction features required in a building are discussed elsewhere.[8, 9]

[8] Bishop, D. E., A Study-Insulating Houses from Aircraft Noise, U. S. Department of Housing and Urban Development, November 1966. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; $0.55

[9] Berendt, R. D., Winzer, G. E., Burroughs, C. B., A Guide to Airborne, Impact and Structure Borne Noise-Control in Multi-family Dwellings, U. S. Department of Housing and Urban Development, September 1967. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; $2.50

The depiction of noise exposure by contours has limitations, since many variables may affect the noise levels heard on the ground during large numbers of aircraft operations. Careful observation will show that two aircraft even of the same class rarely follow exactly the same path with respect to ground track or altitude profiles. Differences may arise due to pilot techniques, temperatures, winds, and aircraft load.

Noise propagation through the atmosphere may also change from day to day and hour to hour due to differences in relative humidity, temperature, and winds. For an aircraft in flight, noise propagation to the ground is somewhat dependent on temperature and humidity but is relatively little influenced by winds. For ground operations, however, winds may be very important in determining the sound levels at a distant position. Noise levels actually heard on the ground are also affected by the terrain and by reflections or shielding from nearby hills, buildings, or other obstacles. Such terrain effects are usually small from noise propagated from aircraft in the air, and are most important for propagation along the ground.

Changes in elevation under the flight path have been taken into account in calculating the NEF contours for departures on Runway 28 at SFO.

Because of the variables discussed above, the accuracy of NEF contours generally decreases as distance from the airport increases due to the greater variability in aircraft paths and sound propagation at large slant distances.

The daily numbers of operations at San Francisco International Airport are given in Tables D-3 and D-4 for 1970 and 1985, respectively. The volume of operations for 1970 is based on that existing between April 1969 and March 1970 as given in the Bay Area Study of Aviation Requirements (BASAR) Airport and Airspace Capacity Analysis report and Section C of ABAG Technical Memorandum II-1. The 380,000 annual airline

Table D-3

DAILY NUMBER OF OPERATIONS AT SAN FRANCISCO INTERNATIONAL AIRPORT — 1970

Aircraft Type		Takeoffs — Stage Length In Nautical Miles				
		Landings	0-500	501-1000	1001-1500	1501-2500
4-Engine Turbojet	Day	52.682	13.035	6.517	2.172	27.156
	Night	11.948	5.431	2.172		8.147
4-Engine Turbofan	Day	83.639	18.466	15.207	13.035	42.363
	Night	24.440	4.888	2.172	1.086	10.862
4-Engine "Stretch Fan"	Day	8.690	1.086			7.604
	Night	5.431			1.086	4.345
3-Engine Turbofan	Day	31.500	13.035	9.776	7.604	4.345
	Night	8.690	1.086	2.172	1.082	1.086
3-Engine "Stretch Fan"	Day	55.397	43.449	5.431	6.517	1.086
	Night	1.086				
2-Engine Turbofan	Day	87.442	77.666	9.776		
	Night	2.172	2.172			
4-Engine HBPR[a] Fan	Day	8.690				8.690
	Night	1.086				1.086
General Aviation Jet	Day	4.345	4.345			
	Night					
2-Engine Prop > 12,500 lb	Day	26.070	27.156			
	Night	1.086				
2-Engine Prop < 12,500 lb	Day	41.277	39.104			
	Night	1.086	3.259			

[a]HBPR = High Bypass Proportion Ratio

Table D-4

DAILY NUMBER OF OPERATIONS AT SAN FRANCISCO INTERNATIONAL AIRPORT — 1985

Aircraft Type		Takeoffs — Stage Length In Nautical Miles				
		Landings	0-500	501-1000	1001-1500	1501-2500
4-Engine-Turbofan	Day	58.904	13.005	10.710	9.180	29.834
	Night	17.213	3.443	1.530	0.765	7.650
4-Engine "Stretch Fan"	Day	12.881	1.610			11.271
	Night	8.051			1.610	6.441
3-Engine Turbofan	Day	14.915	6.172	4.629	3.600	2.057
	Night	4.116	0.515	1.028	0.515	0.515
3-Engine "Stretch Fan"	Day	96.581	75.749	9.468	11.363	1.894
	Night	1.894				
2-Engine Turbofan	Day	39.134	34.758	4.375		
	Night	0.971	0.972			
4-Engine HBPR[a] Fan	Day	71.998	39.624	9.799	8.457	16.178
	Night	12.012	3.213	1.235	0.940	4.564
2, 3-Engine HBPR Fan	Day	158.997	87.505	21.640	18.678	35.727
	Night	25.620	7.095	1.820	2.075	10.077

[a]HBPR = High Bypass Proportion Ratio

operations for 1985 is based on the maximum airport capacity for the existing runway configuration as given in the BASAR Airport and Airspace Capacity Analysis report. These figures were based on a calculated airport capacity before the effects of air turbulence created by large jets were known. The airport capacity figure has been reduced to an estimated value of 310,000 annual airline operations, because this turbulence requires increased spacing of operations.

Flight path tracks for Instrument Flight Rules (IFR) traffic are based on study of standard instrument departure routes. (At some airports, actual instrument departure tracks may show considerable variation from those inferred solely from standard instrument departure procedures.) Information was obtained from airport and tower personnel to define Visual Flight Rules (VFR) flight paths. Flight track utilization was derived from study of origination and destination cities for scheduled airline traffic reported in ABAG Technical Memo II-I, and is shown in Table D-5.

For San Francisco International Airport, the proportion of aircraft types in 1970 was determined from the scheduled aircraft information in ABAG Technical Memo II-I. For 1985, the breakdown of aircraft types was taken from Section C of ABAG Technical Memo II-I.

The contours reflect 380,000 annual air carrier operations by 1985 (approximately 15 percent over 1970) with the size of NEF contours shrinking due to the introduction of the newer, less noisy, high-bypass-ratio turbofan aircraft (Boeing 747, Douglas DC-10, and Lockheed 1011) and the assumed retrofit by 1985 of all 1970 aircraft to meet 1970 federal noise certification standards for new aircraft.

Table D-5

FLIGHT TRACK UTILIZATION PERCENTAGES AT
SAN FRANCISCO INTERNATIONAL AIRPORT — 1970 AND 1985
(1970 RUNWAY UTILIZATION)

Flight Track Segments	Takeoffs		Landings	
	1	2	1	2
01-A			12.0	12.0
01-B	18.2	7.5		
01-C	18.2	7.5		
01-D	36.4	14.9		
01-E	22.8			
01-H	13.5	14.9		
01-I	13.0	23.7		
01-J	13.0	23.7		
01-K	26.0	47.4		
01-L	31.2	31.2		
01-R	31.2	31.2	12.0	12.0
10-A			87.0	87.0
10-B	2.2	2.2		
10-C	2.2	2.2		
10-D	4.3	4.3		
10-E	1.9	3.2		
10-F	2.4	1.1		
10-R	2.2	2.2	87.0	87.0
19-R	0.3	0.3	0.3	0.3
19-L	0.3	0.3	0.3	0.3
28-A	16.4	16.4	0.3	0.3
28-B	16.4	16.4	0.3	0.3
28-C	32.8	32.8	0.5	0.5

Aircraft in each category:
1. Aircraft with trip length < 1500 nautical miles
2. Aircraft with trip length > 1500 nautical miles

For runways 28R and L in 1970, the 30 NEF contour was developed for 170 takeoffs per day. This 30 NEF would correspond to a single event noise exposure level (SENEL) of 79 dBA at night and 85 dBA during the day.[10] For 79 dBA, this is approximately equivalent to a truck going by at maximum highway speed and 150 feet away. For 85 dBA, this would correspond to a truck going by at maximum highway speed at a distance away of between 50 and 70 feet.

The 1970 and 1985 contours are shown in Figures 2-2 and 2-3 indicating land uses related to the contours. Figure 2-4 and 2-5 show schools and hospitals related to the noise contours. (Figures 2-2 through 2-7 are presented in detachable form at the end of this document.)

A net decrease in the number of acres of land, houses, schools, hospitals, and commercial areas affected by noise levels greater than 30 NEF will occur between 1970 and 1985. The areas enclosed within the NEF-30 contours for 1970 and 1985 are itemized in Table D-6. The residential building count within the 30-NEF contour decreases 43.4 percent, from 22,822 units in 1970 to 12,924 units in 1985. The total land area within the NEF-30 contours decreases 35.6 percent, a reduction from 12,078.2 acres to 7,807.9 acres.

These noise contours assumed 380,000 annual airline operations. The final RASS report recommended a capacity of 310,000 annual airline operations, so the 1985 contours would shrink somewhat with the lower number of operations. These contours were made before actual noise data were available for the DC-10 and 1011 high-bypass-ratio transport aircraft. The first available noise data for the DC-10 indicate that the

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[10] Bolt, Beranek and Newman, op cit, pp III-16 through III-19.

Table D-6

LAND USE WITHIN 30-NEF NOISE CONTOUR LEVEL FOR SAN FRANCISCO INTERNATIONAL AIRPORT

Land Use	1970	1985[a]
Residential		
Acres	3,685.7	2,123.0
Building Count	22,822	12,924
Schools		
Acres	177.9	96.2
Building Count	36	21
Hospitals		
Acres	2.9	0
Building Count	1	0
Commercial		
Acres	2,852.8	1,821.6
Vacant		
Acres	3,130.6	2,002.4
Airport		
Acres	1,855.2	1,588.3
Cemetary		
Acres	373.0	176.5
Total Acres	12,078.1	7,807.9

[a] Assumes no change in land use between 1970 and 1985.

Source: P. Dygert, J. Ungerer, Airport Noise and Land Use, ABAG, March 1972

actual takeoff noise levels at full thrust are substantially less (5 to 8 EPNdB) than the earlier industry estimates. These lower noise levels will also result in reductions in the size of the projected 1985 NEF take-off contours. The land areas within the 30-NEF contours for 1985 would be less than indicated in Table D-6.

New California noise regulations stipulate that by 1985 noise impacts on residential areas over CNEL 65 will not be permitted. The Final Plan Recommendation of RASS concluded that this noise criteria could be met through taking certain actions. A noise monitoring program is being set up for the San Francisco International Airport to see that the California noise regulations are met.

Figures 2-6 and 2-7 show parks, recreational areas, and wildlife areas as related to the noise contours. As can be seen from reviewing the noise contours superimposed on the various land uses and comparing the data with Table D-2, some conflicts are evident.

APPENDIX E

Appendix E

AIR QUALITY

In February 1971, the Bay Area Pollution Control District produced a report, Aviation Effect on Air Quality. This report described the existing air quality in the Bay Area in 1970 and the expected air quality in 1975, 1980, and 1985. It calculated the amount of emissions expected from aircraft at each airport in the future years, as well as emissions expected from other sources. The following paragraphs are a synopsis of that report.

Total emissions of air contaminants to the atmosphere from all sources in the nine-county San Francisco Bay Area are expected to decline substantially over the next 15 years, but the portion attributable to aviation activity at all airports will increase. Total nine-county emissions for 1970 are estimated to be 9,463 tons per day. This will decline to 3,600 by 1985, with the aviation portion increasing from 138 tons per day to 200[1] for all airports in the Bay Area. Emissions from aircraft are estimated on the basis of operations within the airshed below an altitude of 3,500 ft. The emissions at San Francisco International Airport are expected to decline slightly between 1970 and 1985.

Total emissions are as estimated by the Bay Area Air Pollution Control District and include factors that are not detailed in this statement. Among the basic assumptions that underlie these calculations are that new motor vehicles will meet federal and state emission requirements for each model year from 1971 to 1976, that no more stringent controls will be mandated for models later than 1976, that the retirement/replacement ratio of auto-

[1] Gillfillan, op. cit.

mobiles will remain constant, that the regulations of the District will be fully effectuated within the nine-county Bay Area, and that area-wide growth will continue.

Aircraft emission rates per operation by type of aircraft are shown in Tables E-1 and E-2.

The newer jet aircraft such as the DC-10 and 747 have generally "cleaner" engines than the 707 or DC-8. This comparison is shown on Table E-1. The "cleaner" generally means a lowering of particulates. The total amount of pollutants for the new engines is comparable to the 707 or DC-8 engines, but there are some differences in particular emission levels. The tables show that particulates are lower for the 747 and DC-10 than for the 707 or DC-8. For carbon monoxide (CO), the DC-10 is much higher and the 747 is almost half way between the figures for various DC-8 or 707 engine types. For nitrous oxides (NO_x), the DC-10 is much higher and the 747 is slightly higher than the DC-8 or 707. For the organics, the DC-10 and 747 are considerably lower and for sulfur dioxide, they are about comparable to the 707 and DC-8. The Bay Area Air Pollution Control District used all of these figures in their calculations and evaluation of future air quality in the Bay Area.

Table E-1

COMMERCIAL AIR CARRIER EMISSION FACTORS

Aircraft and Engine	Fuel per Engine per Operation (gal)	No. of Engines	Total Fuel per Operation (gal)	Contaminant Emissions per Aircraft (lb/operation)					
				Part	CO	NO_x	Org.	SO_x	Total
Convair 880									
CJ805	64	4	256	19.5	33.0	10.0	36.4	4.0	103
Rotorcraft	10	2	20	1.5	2.6	0.8	2.8	0.3	8
B-720									
JT3C	89	4	356	23.1	39.9	9.6	9.3	5.6	88
JT3D	89	4	356	22.4	84.7	11.7	50.6	5.6	175
B-737-200, DC-9									
JT8D Old	66	2	132	10.7	19.0	4.2	7.5	2.1	44
New	66	2	132	7.9	16.2	6.3	4.0	2.1	37
B-727-100, B-727-200									
JT8D Old	66	3	198	16.0	28.5	6.3	11.3	3.1	65
New	66	3	198	11.9	24.4	9.5	5.9	3.1	55
B-707, DC-8, DC-8-60									
JT4	89	4	356	24.9	65.5	7.5	27.8	5.6	131
JT3D	89	4	356	22.4	84.7	11.7	50.6	5.6	175
DC-10, L-1011									
CF6 or RB. 211	111	3	333	11.0	42.6	65.6	11.0	5.2	135
B-747									
JT-9D	95	4	380	12.5	71.1	13.3	12.9	5.9	116

Table E-2

GENERAL AVIATION EMISSION FACTORS AND FUEL USAGE

Engine	Part.	Emission Factors (lb/100 gal fuel)			
		CO	NO_x	ORG.	SO_x
Jet	7.6	12.9	1.9	4.3	1.56
Turboprop	10.4	5.4	5.6	3.9	1.56
Gasoline	1.2	245.0	14.7	49.6	-

Aircraft	Fuel Usage (gal/operation)	Emission Factors (lb/operation)				
		Part.	CO	NO_x	Org	SO_x
Gasoline						
Single engine						
1-3 place	1.0	0.012	2.45	0.147	0.496	-
4+ place	1.5	0.018	3.67	0.221	0.744	-
Multiengine						
Under 600 hp	3	0.036	7.35	0.441	1.488	-
Over 600 hp	8	0.096	19.6	1.176	3.968	-
Rotocraft	1	0.012	2.45	0.147	0.496	-
Turbine Fuel						
Turboprop[a]	25	2.6	1.35	1.4	0.975	0.39
Turbojet	64	4.86	8.26	1.22	2.75	1.00
Third-level air carrier[a]	25	2.6	1.35	1.4	0.975	0.39

[a] Third level air carriers counted with general aviation.

These emission rates were obtained from a variety of sources and in certain instances data were conflicting, so the information was selected, averaged, or thrown out, depending on judgmental decisions by Bay Area Pollution Control District personnel. The emission rates were then multiplied by the number of aircraft operations in each category in 1970 and 1985 to obtain the number of tons of pollutants per day emitted.

The report Aviation Effect on Air Quality estimated 442,900 annual airline operations in 1985 at San Francisco International Airport. The Regional Airport Systems Study Final Plan Recommendation stated that San Francisco International Airport has a recommended airline operation capacity of 310,000 annual movements in 1985. To estimate the pollutant emissions in 1985 for this lower figure, each type of aircraft operation for 1985 was reduced by a factor of 3,100, divided by 4,429, and then totaled. Helicopter operations and general aviation operations were taken to be the same as in the report on Aviation Effect on Air Quality.

The results are given in Tables E-3 and E-4, which show the estimated pollutants produced by vehicles and aircraft on San Francisco International Airport in 1970 and 1985. In addition, vehicles going to and from the airport are expected to produce 38 tons per day of pollutants in 1985. This figure was calculated using the 80-tons-per-day figure quoted in the RASS Final Plan Recommendation for all airline airports for the Bay Area and proportioning the 80 tons among the airports based on the estimate of annual passengers who are expected to use automobiles.

Table E-3

AIR CONTAMINANT EMISSIONS
AT
SAN FRANCISCO INTERNATIONAL AIRPORT — 1970
(tons per day)

	Part.	Co	No	Org	SO_x	Total
Aircraft emissions						
Air carrier	8.1	22.3	3.6	11.7	1.8	47.5
Jet fuel dumping	—	—	—	1.8	—	1.8
General aviation	0.1	0.1	0.1	0.1	—	0.4
Subtotal	8.2	22.4	3.7	13.6	1.8	49.7
Ground emissions (nonaircraft)						
Motor vehicles	0.1	8.5	0.6	1.6	—	10.8
Fuel handling	—	—	—	0.1	—	0.1
Engine test cell	0.4	1.1	0.2	0.6	0.1	2.4
Subtotal	0.5	9.6	0.8	2.3	0.1	13.3
Total emissions	8.7	32.0	4.5	15.9	1.9	63.0

Table E-4

AIR CONTAMINANT EMISSIONS
AT
SAN FRANCISCO INTERNATIONAL AIRPORT — 1985
(tons per day)

	Part.	Co	No	Org	SO_x	Total
Aircraft emissions						
Air carrier	5.9	20.3	12.7	6.4	2.0	47.3
General aviation	0.2	0.2	0.1	0.1	—	0.6
Subtotal	6.1	20.5	12.8	6.5	2.0	47.9
Ground emissions (nonaircraft)						
Motor vehicles	0.1	1.2	0.2	0.1	0.1	1.7
Fuel handling	—	—	—	—	—	0.2
Engine test cell	0.4	1.2	0.6	0.5	0.1	2.8
Subtotal	0.5	2.4	0.8	0.8	0.2	4.7
Total emissions	6.6	22.9	13.6	7.3	2.2	52.6

The total air emissions are summarized in Table E-5, which indicates that the SFO-related air contaminant emissions for 1985 will decrease over 1970 levels.

Table E-5

TOTAL NINE-COUNTY AIR EMISSIONS
(tons per day)

	Nine-County 1970	SFO 1970 Portion	Nine-County 1985	SFO 1985 Portion
Total nine-county (all sources)	9,463	246	3,600	90.6
Aircraft	121	49.7	200	47.9
Other airport	17	13.3	10	4.7
Autos to airports	NA	183.0	80	38.0

The number of automobiles to and from the airport will increase in 1985 as compared with 1970. The emissions from automobiles traveling to or from the airport will go down from an estimated 183 tons per day in 1970 to 38 tons in 1985. This marked reduction is due to more stringent auto pollution devices required of car manufacturers. The 1970 figure was calculated as follows:

Emission	1970 – Grams/Mile
CO (Urban)	95.0
HC (Urban)	14.7
NO_x	6.63
Particulates	0.3
SO_2	0.11

Source: E. P. A., Compilation of Air Pollutant Emission Factors, February, 1972

The emissions are for the average car in 1970. The average passenger's one-way auto trip is 21 miles to the airport and the average employee's one-way auto trip is 14 miles. In 1970 there were an estimated 50, 000 average daily passenger auto trips to and from the airport and 27, 000 average daily employee auto trips to and from the airport.

Pollutant levels caused by airport operations at specific community locations are also of concern. Aircraft ground operations and ground vehicle operations have the greatest potential for adverse effects upon adjacent communities. The Bay Area Pollution Control District developed a "hybrid diffusion model" as applied to the operations at San Francisco International Airport to assess quantitatively the community impact. This is a mathematical model calculated by a computer, and is explained in detail together with the relevant assumptions in Aviation Effect on Air Quality Regional Airport Systems Study, February 1971. The results of the model are described in the following paragraphs.

At San Francisco International Airport, the present demand levels already show an appreciable impact on air quality (see Table E-6). At receptor sites 2 and 4 near the ends of the major runway complexes (see Figure E-1), high levels might be expected. Nevertheless, the calculated levels

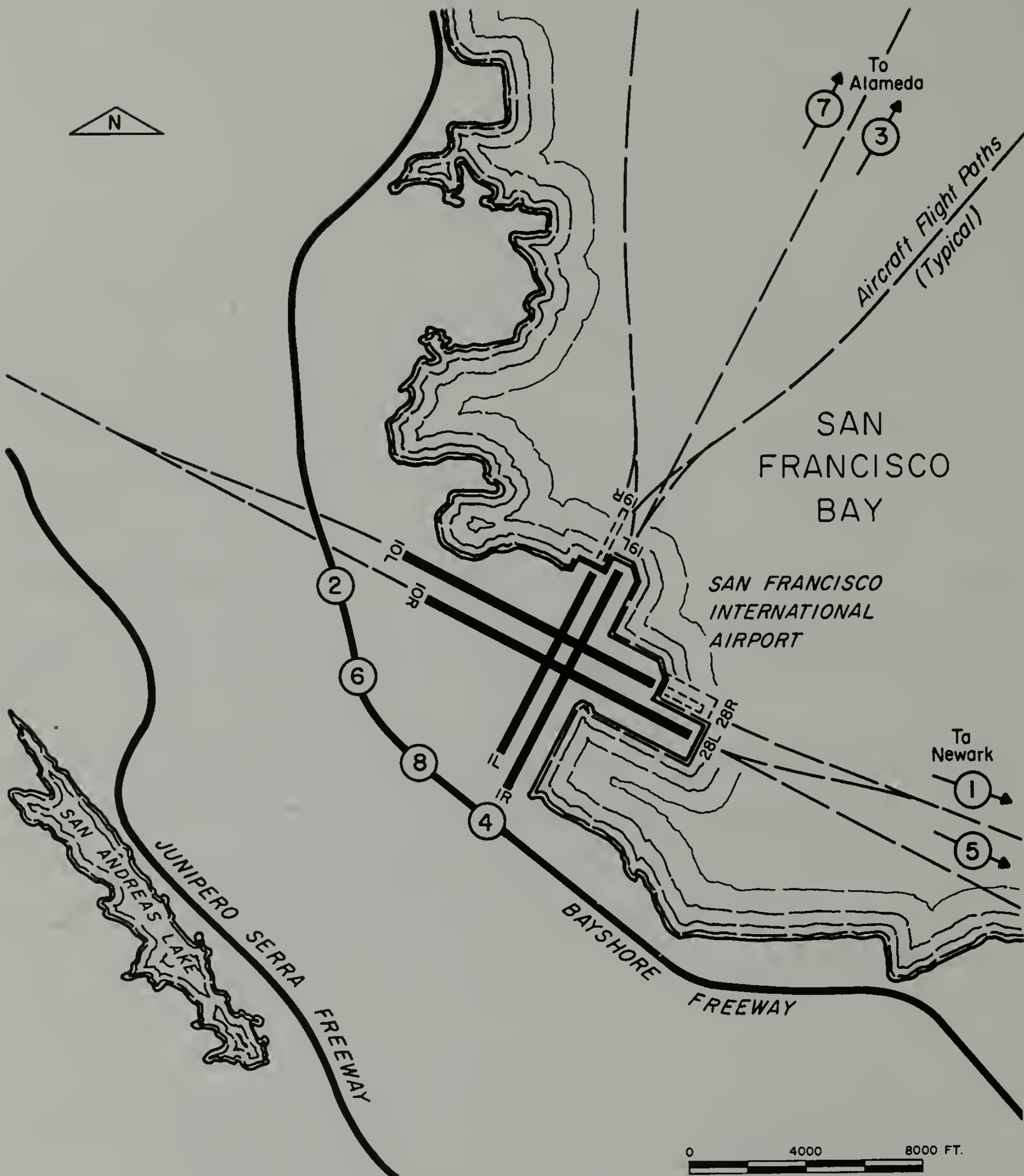


Figure E-1. Location of Receptors

Table E-6

CALCULATED AIR QUALITY IMPACT FROM AIRCRAFT GROUND OPERATIONS AND ASSOCIATED AUTOMOTIVE TRAFFIC UNDER PRESENT (1970) DEMAND LEVELS AT INDICATED DOWNWIND RECEPTOR SITES

	Receptor Site							
	SFO-AGO				SFO-AAT			
Contaminant	1	2	3	4	5	6	7	8
Particulates ($\mu g/m^3$:24-hr avg)								
C	1	312	3	490	1	28	T	28
E	21	698	34	1070	4	46	1	46
Carbon monoxide (ppm)								
C	T	3.0	T	4.7	T	2.0	T	2.0
E	0.6	14.0	0.9	21.2	0.6	5.6	0.2	5.6
Nitrogen oxides (ppm)								
C	T	0.24	T	0.38	T	0.14	T	0.14
E	0.05	1.12	0.08	1.70	0.04	0.39	0.01	0.39
Organics (ppm, as butane)								
C	T	0.70	0.01	1.09	T	0.20	T	0.20
E	0.14	3.25	0.23	4.92	0.06	0.56	0.02	0.56
Sulfur oxides (ppb)								
C	1.3	54.0	5.6	84.6	—	—	—	—
E	10.4	252.0	16.4	382.0	—	—	—	—

Note: AGO — Aircraft Ground Operations
AAT — Associated Automotive Traffic
T — Trace
C — Typical Unstable Meteorological Conditions
E — Adverse Stable Meteorological Conditions

are surprisingly high for particulates and for sulfur oxides. Particulate levels under C conditions (typical unstable) at site 4 are 490 micrograms per cubic meter, which is almost five times the California State standard of 100 micrograms per cubic meter for 24-hour particulates. These levels must be considered in addition to a background from all other upwind Bay Area sources, which already show levels in excess of 60 micrograms per cubic meter at Bay Area Air Pollution Control District monitoring stations.

One ameliorative factor is operative in air traffic control procedures at San Francisco International Airport. Under light-wind conditions, the 28L-28R runway complex is used for landings, and the perpendicular 1L-1R runway complex is used for takeoffs. Thus, under conditions most likely to be adverse, the concentrations at sites 2 and 4 are substantially reduced (by a factor approaching two).

At receptor site 4 (in Burlingame), actual particulate levels have been monitored by the Bay Area Air Pollution Control District in 1970. Values as high as 240 micrograms per cubic meter have been measured (under C stability conditions with an elevated marine inversion), thus confirming very well the calculations and the model, as adjusted to airport operating practices.

The other contaminants can be evaluated in terms of hourly rather than 24-hour averages, and none of them exceeds State standards. However, the SO_2 level of 84.6 ppb would, if sustained for 12 hours, give a 24-hour average in excess of the State standard of 40 ppb. The CO level of 4.7 ppm could, when added to freeway levels, cause State standards to be exceeded (as has been observed at Burlingame). The organics level of 1.09 ppm is not serious in terms of photochemical oxidant formation at

the site, but reactive components of the exhaust may add to oxidant formation downwind. In addition, the level is high enough to create odor problems at sites 2 and 4.

Receptor site 1, 27 kilometers downwind, is of interest since it lies in the Newark-Fremont area with frequently measured high contaminant values. At this distance, the impact of San Francisco International Airport is not calculated to be significant, except for particulates under E conditions. Since E conditions could be sustained over smooth water at night, the particulate contribution of 21 micrograms per cubic meter cannot be completely disregarded.

The future projections for San Francisco Airport (see Tables E-7 and E-8) do not show any major differences from present conditions. There is slight improvement with increasing controls at the 450,000 annual aircraft operations level, followed by return to present values at a level of 588,000 annual aircraft operations. These levels are far in excess of the 370,000 annual operations now expected to be the total airport capacity. The 370,000 total runway operations includes 310,000 airline operations and 60,000 other aviation-type operations. The annual airport capacity has been reduced because of turbulence caused by large aircraft, resulting in a greater separation between aircraft than occurred in 1970. This means that the expected pollution levels will be less than shown in the Tables E-7 and E-8.

In the Bay Area, an inversion layer occurs a large percent of the time between 2500 and 3000 feet, which keeps pollutants below the inversion. Pollutants above the inversion layer mix and disperse in the atmosphere. No definitive studies have yet been made of air pollution caused by aircraft above 3500 feet and below the upper atmosphere. The Mitre Corporation of Virginia has a study in progress which may provide data on this subject.

Table E-7

CALCULATED AIR QUALITY IMPACT FOR AIRCRAFT GROUND OPERATIONS AND ASSOCIATED AUTOMOTIVE TRAFFIC FOR 450,000 TOTAL ANNUAL AIRCRAFT OPERATIONS AT DOWNWIND RECEPTOR SITES

Contaminant	Receptor Site							
	SFO-AGO				SO-AAT			
	1	2	3	4	5	6	7	8
Particulates ($\mu g/m^3$:24-hr avg)								
C	1	290	3	456	1	28	T	28
E	20	650	32	990	4	46	1	46
Carbon monoxide (ppm)								
C	T	3.5	T	5.5	T	0.6	T	0.6
E	0.7	16.4	1.1	24.8	0.2	1.6	0.1	1.6
Nitrogen oxides (ppm)								
C	0.02	0.69	0.07	1.10	T	0.12	T	0.12
E	0.14	3.22	0.23	4.90	0.03	0.32	T	0.32
Organics (ppm, as butane)								
C	T	0.70	0.01	1.09	T	0.04	T	0.04
E	0.14	3.25	0.23	4.92	0.01	0.11	T	0.11
Sulfur oxides (ppb)								
C	1.6	67.6	70.0	106.0	–	–	–	–
E	13.4	315.0	20.5	477.0	–	–	–	–

Note: AGO – Aircraft Ground Operations
AAT – Associated Automotive Traffic
T – Trace
C – Typical Unstable Meteorological Conditions
E – Adverse Stable Meteorological Conditions

Table E-8

CALCULATED AIR QUALITY IMPACT FOR AIRCRAFT GROUND OPERATIONS AND ASSOCIATED AUTOMOTIVE TRAFFIC FOR 588,000 TOTAL ANNUAL AIRCRAFT OPERATIONS AT DOWNWIND RECEPTOR SITES

Contaminant	Receptor Site							
	SFO-AGO				SOF-AAT			
	1	2	3	4	5	6	7	8
Particulates ($\mu g/m^3$:24-hr avg)								
C	1	312	3	490	2	56	T	56
E	21	698	34	1070	8	92	2	92
Carbon monoxide (ppm)								
C	T	4.4	0.1	6.9	T	0.2	T	0.2
E	0.8	20.6	1.4	31.2	0.1	0.5	T	0.5
Nitrogen oxides (ppm)								
C	T	1.28	0.01	2.02	T	0.05	T	0.05
E	0.27	5.96	0.43	9.05	0.01	0.13	T	0.13
Organics (ppm, as butane)								
C	T	0.65	T	1.01	T	0.01	T	0.01
E	0.13	3.02	0.21	4.57	T	0.03	T	0.03
Sulfur oxides (ppb)								
C	1.6	67.5	7.0	106.0	0.4	11.8	0.1	11.8
E	13.0	315.0	20.5	478.0	4.6	32.4	1.2	32.4

Note: AGO — Aircraft Ground Operations
AAT — Associated Automotive Traffic
T — Trace
C — Typical Unstable Meteorological Conditions
E — Adverse Stable Meteorological Conditions

APPENDIX F

Appendix F

EMPLOYMENT IMPACT

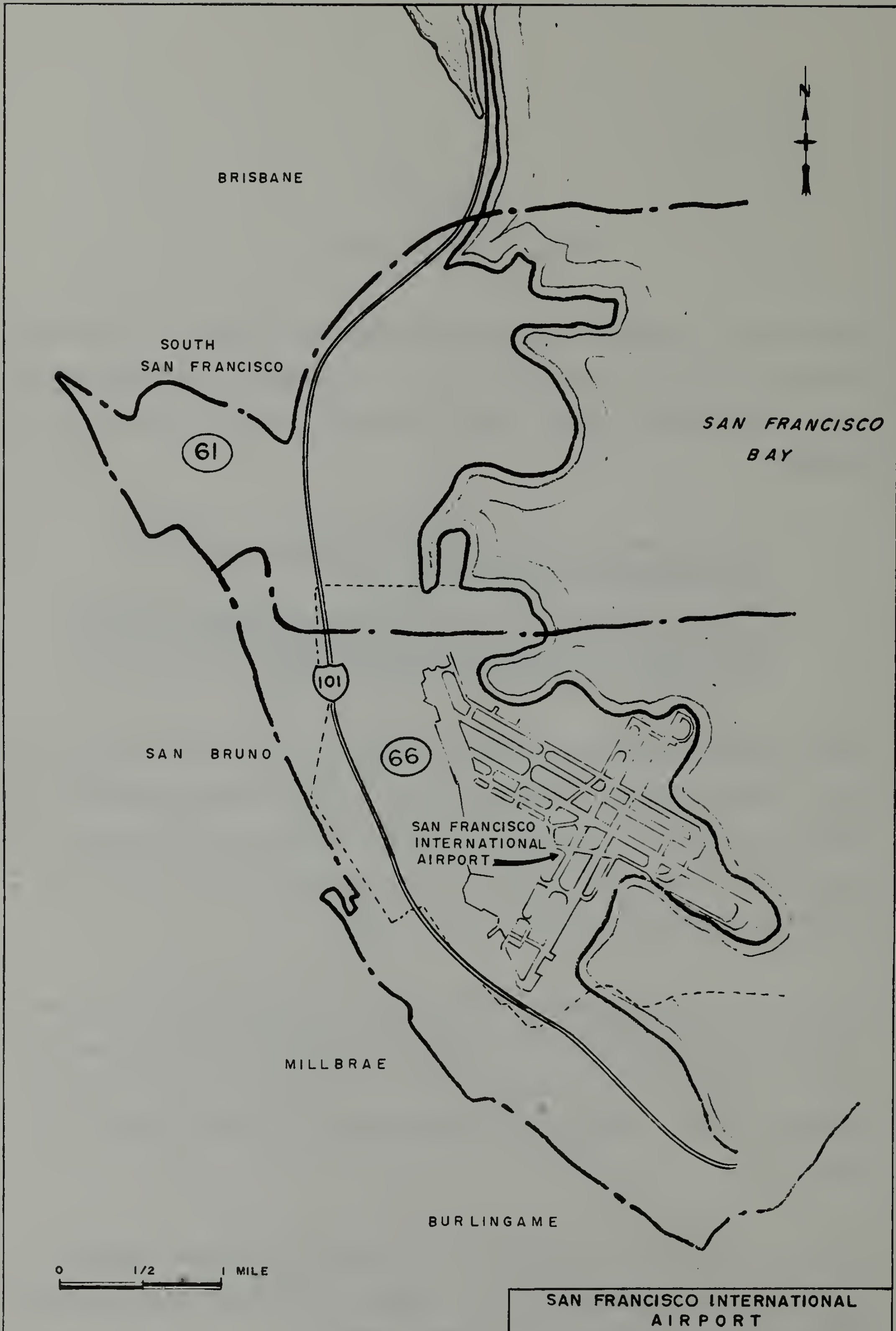
The proposed expansion, together with more passengers, will increase the number of employees working on or immediately adjacent to the airport. The following reports have described the expected employment changes:

- Wilsey and Ham, The Effect of Aviation on Physical Environment and Land-Uses, 1971
- William Goldner, et al., Economic and Spatial Impacts of Alternative Sizes and Locations in the San Francisco Bay Region, July 1971, Volumes 1 and 2

These reports documented employment areas on and adjacent to the airport. These areas were labelled by the Bay Area Transportation Study Commission (BATSC) as zones 61 and 66. Zone 61 corresponds to census tract 003 and zone 66 includes census tracts 024, 029, and 033 all in San Mateo County, as shown in Figure F-1.

Table F-1 lists the expected changes in "basic employment" between 1965 when the airport had 8.7 million total annual passengers and 1985 with 31.0 million annual passengers. The "basic industries" were determined in the previously cited reports and are defined later in this report.

Table F-1 shows that of the 24,139 total basic employee increase, 13,655 in the Air Transportation, Hotel, and Federal Government categories are due only to air passenger growth.



SAN FRANCISCO INTERNATIONAL AIRPORT

ENVIRONMENTAL IMPACT REPORT

AIRPORT LOCATION

WITHIN BAY AREA TRANSPORTATION STUDY COMMISSION ZONES 61 & 66

FIGURE F-1

Table F-1

FUTURE BASIC EMPLOYMENT CHANGES –
SAN FRANCISCO INTERNATIONAL AIRPORT

Basic Employment (number of employees)	Zone 61			Zone 66			Total Zones 61/66		
	1965	Change	1985	1965	Change	1985	1965	Change	1985
Air transportation	0	0	0	14,140	12,061	26,201	14,140	12,061	26,201
Hotels	110	1,214	1,324	347	0	347	457	1,214	1,671
Federal government	36	390	426	897	0	897	933	390	1,323
Wholesale trade	3,786	3,156	6,942	2,525	0	2,525	6,311	3,156	9,467
Other basic	8,307	3,755	12,062	4,158	3,563	7,721	12,465	7,318	19,783
	12,239	8,515	20,754	22,067	15,624	37,691	34,306	24,139	58,445

Note: Annual passengers enplaned and deplaned at SFO in 1985 = 31,000,000

Each "basic industry" that has shown significant economic relationships with the air transportation industry was evaluated on the basis of the following criteria:

- The dollar volume of transactions interchanged with the air transportation industry
- The relative concentration of the industry around San Francisco International Airport in 1965 based on BATSC survey results[1]
- The logical association of the industry with the near-airport location requirement

From this analysis, four "basic industry" categories were selected as being significantly influenced by the near-airport location feature. These industries, together with their two-digit Standard Industrial Classification (SIC) numbers as assigned by BATSC, are as follows:

Industry	SIC Number
Transportation by air	45
Hotels and other lodging places	70
Federal government	91
Wholesale trade	50

1 Unpublished tabulations of employment by two-digit SIC number in each BATSC Map Zone from the 1965 BATSC survey.

The air transportation industry is by far the most important of the four, rating very high under all three criteria. The hotel industry is becoming increasingly important around major airports. The federal government is primarily the FAA. The wholesale trade industries locate near transportation facilities generally and only certain segments of wholesale trade are heavy users of suppliers for air transportation.

Some industries were not included in the above tabulation. The petroleum industry (SIC number 29) was omitted even though it is a relatively important supplier to the air transportation industry. Most of the "basic" part of the petroleum industry in the Bay Area is located in Contra Costa County where the large petroleum refineries have good harbor access for their tankers on the northeastern part of San Francisco Bay. There is very little employment in this industry located near the commercial airports of the region even though commercial aircraft are important petroleum consumers. Aircraft fueling is done primarily by airline employees, who are included in the air transportation employment category. There is no reason to expect that airport location or activity levels will significantly affect petroleum industry location in the future.

The transportation equipment industry (SIC number 37), which includes aircraft, aero engines, parts, etc., was also omitted. Prime manufacturers of commercial aircraft generally locate on or adjacent to airports (although not necessarily major commercial airports). Subcontractors will often locate around these prime industries. However, there are no prime commercial aircraft manufacturers located in the Bay Area and there is no good reason to expect a prime aircraft manufacturer to move into the region in the foreseeable future. It should be noted, however, that aerospace-oriented companies and other research and development firms are generally heavy users of air transportation and are often motivated to locate their facilities around major commercial airports.

These types of companies are represented in a large number of industry categories, however, which makes them difficult to identify from a two-digit SIC industry breakdown.

The state government is a significant user of air transportation, but this industry was also not included. State offices in the Bay Area are primarily located within the central business districts (primarily downtown San Francisco). Most state aviation regulatory groups and agencies are located in Sacramento. No change in these patterns in the future is expected.

It has been assumed that air transportation employment around airports is a direct function of the passenger traffic levels at those airports.

During the base year, 1965, there was only one major commercial airport in the Bay Area — San Francisco International. In 1965 there were 14,140 air transportation employees at or around the San Francisco Airport. Virtually all of these were located within BATSC Map Zone 66. Of this total about 6,000 were employed at United Air Lines' jet maintenance base located at the San Francisco Airport. The remaining 8,140 were directly associated with activity at the airport. With 8.7 million passengers enplaned and deplaned at San Francisco International in 1965, a ratio of 1,069 passengers per employee results:

$$\frac{8,700,000}{8,140} = 1,069$$

As with most highly mechanized industries, air transportation employees are becoming more productive over time. There is an average annual increase in passengers per employee of about 4.7 percent per year. It is assumed that this is a normal rate of employee productivity increase which will continue in the future. Thus, by 1985, for example, air transportation employees at San Francisco International Airport will service

about 2,672 annual airport passengers per employee, resulting in a total of 26,201 employees for 31 million annual passengers.

The same general method was used to project future employment levels at United's jet maintenance base. However, because this facility is used to service United's total system operations, the relationship was established between these employees and the total passengers on United's system. There is no direct relationship between the number of employees at the maintenance base and airline passengers at San Francisco Airport. In 1965 United enplaned and deplaned about 34.4 million passengers for their total system. This means that the 6,000 employees at their jet maintenance base in San Francisco served about 5,731 United passengers per employee. Again, assuming normal industry productivity increase, this figure would increase by about 4.7 percent per year. Thus, by 1985, United's maintenance base employees will be able to serve about 14,330 system airline passengers per employee. The size of the employment force depends on the size of United's aircraft fleet, employee efficiency, and the aircraft fleets' mechanical efficiency.

Hotel employment is generally a function of the number of hotel rooms available. A full-service hotel will employ about one person for every 3.5 rooms. This ratio has not and is not expected to change substantially. Hotel rooms around San Francisco International Airport exist at a rate of about 1,000 rooms for every 5 to 5.5 million enplaned and deplaned passengers. The assumption is that future hotel expansion will take place at a rate of about 1,000 rooms per 5.3 million passengers. This results in about 54 hotel employees per one million airline passengers, or 1,671 hotel employees when the air port reaches 31 million annual passengers.

Federal employees associated with the operations of a major commercial airport can be considered as a specialized group of air transportation employees. There were about 8.7 air transportation employees at San Francisco International Airport in 1965 for every federal employee in the

airport area. It is assumed that this ratio of one federal employee for every 8.7 air transportation employees will continue in the future, resulting in 1,323 federal employees.

It is difficult to establish meaningful relationships between the wholesale trade industry and airport traffic levels. Segments of this industry are important suppliers to air transportation and other segments are important air transportation users (particularly of air cargo service). Still other segments of the industry locate around airports because of the availability of other modes of transportation. As traffic grows around an airport, certain segments of the wholesale trade industry located there would expand. On the other hand, expansion of other types of industry around the major airports will create increasing land values and surface transportation congestion conditions, which will tend to deter the growth of some segments of the wholesale trade industry. For these reasons, it has been assumed that, as a group, the wholesale trade establishments now located around the major airport sites will grow at about the same rate as projected for this industry in the region as a whole.

The area around each major airport will contain categories of "basic employment" other than those associated with the four industries above. For example, in 1965 about 36 percent of the "basic employment" in Map Zones 61 and 66 around San Francisco International was in other "basic industries." No one industry other than the four discussed above appears singularly significant. However, it is reasonable to assume that as a general rule these employees represent companies that for various reasons find it advantageous to be located in the general vicinity of the airport. It has been assumed that employment in each of these "other basic industries" located in the area around a major airport will grow at the same rate as that projected for each specific industry in the region as a whole. The regional industry growth rates represented by these data

are applied to the base year employment levels of each industry located in a particular airport's area to calculate the "other basic industry" employment for that area during any future time period.

The figures in Table F-1 are slightly lower than shown in the previously cited reports. This is because employment figures were reduced in the air transportation, hotel, and federal employee categories to reflect 31 million annual passengers in 1985 instead of 32.65 million annual passengers used in the reports.

No set standard has been rigorously adhered to in determining the acreage required to accommodate "basic industry" growth around major airport sites in the future. Generally, basic industry land requirements range between 10 and 20 employees per acre in the Bay Area depending upon the specific industry involved and the general intensity of land usage in the specific area of the region being considered. For example, the amount of usable industrial acreage available in the area around San Francisco Airport is becoming relatively scarce so that future development in this area will warrant more intensive land usage than would be true in less urbanized areas of the region. It is assumed that all air transportation employees at a given airport will be employed on the airport property itself. Thus, at San Francisco Airport, where the land available for expansion is limited, future employment densities on the airport property (exclusive of land requirements for runways, taxiways, etc.) may run as high as 50 to 55 employees per acre in the future.

Hotels also represent a higher intensity land use than most "basic industries" being considered. It has been assumed that hotel acreage requirements will be about 90 rooms per acre in any of the major airport areas. Where land is available for development, it has been assumed that air transportation, federal government, and wholesale trade will develop at

an intensity of about 10 employees per acre. Other "basic industries" locating around the major airports will develop at a higher intensity of about 20 employees per acre. From these assumptions, all the usable vacant land existing in 1965 in zones 61 and 66 will be utilized by 1985.

APPENDIX G

Appendix G

WILDLIFE BREEDING, NESTING, FEEDING GROUNDS

The Regional Airport Systems Study, The Effect of Aviation on Physical Environment and Land Uses in the Bay Region prepared by Wilsey and Ham, describes the existing knowledge of the ecological relationships between species living in the Bay Region and environmental changes instigated by man. The physical characteristics of animal and vegetative species within the wildlife habitats adjacent to the airport are described. Due to limitations of resources and time, only a general identification of these complex and intricate habitats based on today's knowledge was made. Only through more detailed research and analysis of these habitats will man begin to understand their ecological relationships and his impact on them through modification of the environment.

Shallow Bay waters are on the east side of the airport. These waters, as they move by tidal action across the mud flats and into the marshes, serve as a transfer medium. They bring water and minerals to the salt marsh and remove food and oxygen as they leave. They supply the filter-feeding invertebrates in the mud with life-giving detritus. They move the fish, particularly in their young stages, into the rich mix along the edges of the Bay. And finally, they provide the medium in which some diving birds — e.g., grebes, mergansers, and loons — may find sustenance, or through which diving ducks — e.g., canvasbacks and scaup — may descend to their food in the muds below. Most of the organisms in the water are minute but play a major role in the intricate web of life.

The phytoplankton of the Bay is dominated by diatoms with some 27 genera being represented. A few single-celled green algae and dinoflagellates are also present in Bay waters. Diatoms may at times be so prevalent that about 10,000,000 are present in a quart of Bay water.[1] However, in spite of their large numbers, their open-water production of food for aquatic life compared to production in salt marshes is but a small fraction of the whole.

Protozoans in the Bay are mainly either ciliates or flagellates. These microscopic animals sometimes occur in concentrations of 20,000 per quart and may represent some six different genera.[1]

There are four major groups of zooplankton represented in Bay waters. They range from the microscopic plants and animals listed above to the larger forms, such as the fish, which will be discussed later. The four major groups are:

- Polychaeta larvae (segmented worms)
- Copepods (crustacean forms)
- Fish larvae
- Snail larvae

The copepods are by far the most abundant and widespread of these forms of life with as many as 75 per quart being taken per sample. They are barely visible to the naked eye because they are often less than one-eight of an inch long.

Shrimp constitute an important part of the Bay ecosystem because they forage for food both on the bottom and in the waters of the Bay. The

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[1] Storrs, P.N., Sellek, R.E., and Pearson, E.A., A Comprehensive Study of San Francisco Bay, 1963-64, S.E.R.L. Report 65-1; Berkeley, University of California, 1965

three shrimp types that are common or of great ecological importance are the Bay shrimp (Crago franciscorum), the blacktail shrimp (Crago nigricauda), and the opossum shrimp (Neomysis awatschansis). The Bay shrimp was once highly priced as human food, but with the present high level of pollution of the Bay it is not so used. The opossum shrimp is the major food of young striped bass, an important sport fish.

There are about 125 species of fish in the Bay.[2] San Francisco Bay plays a vital part in both commercial and sports fishing. It has been estimated that over $20 million dollars per year are spent on sports fishing alone. The State Department of Fish and Game has conducted surveys during recent years (1963-66) that indicate great numbers of certain species. Striped bass, for example, are thought to comprise a population of several million. The northern anchovy and shiner perch are probably even more numerous. Of some 70 species caught in the Department study of San Francisco Bay proper, the highest species diversity was near Treasure Island. The lowest diversity (average of 10 species) was found south of Dumbarton Bridge.[3] The following is a list of the 20 most common fish species south of the Richmond Bridge, listed by relative abundance:

Northern anchovy (most numerous fish in the Bay)
Shiner perch
English sole
Pacific herring
Bay goby
Speckled sandab
Jacksmelt
White croaker
Pacific staghorn sculpin
Pacific tomcod
Northern midshipman
Topsmelt

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[2] Aplin, A., San Francisco Bay Study, Menlo Park, 1963; and Skinner, J. E., An Historical Review of the Fish and Wildlife Resources of the San Francisco Bay Area, 1962

[3] Aplin, A., San Francisco Bay Study, Menlo Park, 1963

California tonguefish
American shad
Pile perch
Starry flounder
Bat ray
Brown smooth hound shark
Spiny dogfish shark
Leopard shark

The grazing filter-feeders that depend on plankton are at the top of the list, while large predator types such as sharks are at the bottom, thus exemplifying the typical pyramid of numbers in a predator food chain. In the northern bays the striped bass would be included well up the list because of its great abundance.

The major type of bird using the shallow waters dives for food. Some catch food near the surface: pelicans and terns. Others dive into water several feet: loons, grebes, and mergansers. The diving ducks go all the way to the bottom to feed in the mud.[4] Some of the common birds of the shallow waters are listed below:

- Diving fish-feeders

    Western grebe
    Eared grebe (often eat feathers)
    Red-throated loon
    Double-crested cormorant
    Red-breasted merganser

- Diving ducks

    White-winged scoter
    Surf scoter
    Greater scaup
    Lesser scaup
    Canvasback
    Ruddy duck

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[4] Sibley, C.G., The Birds of the South San Francisco Bay Region, San Jose, 1952

- <u>Surface feeders</u>

  Brown pelican
  Caspian tern (nests along Bay)
  Forster's tern (nests along Bay)
  Least tern (endangered species — nests along Bay)
  Gulls (five species)

Mammals of the shallow waters are relatively sparse; only the harbor seal and the sea lions can be called common. Porpoises sometimes find their way into San Francisco Bay. Some 300 to 400 harbor seals live in the Bay and require hauling out areas along the shore for resting.

Mud flats are an extensive feature of San Francisco Bay and cover tens of thousands of acres. The flats are substrate that may have a moisture content of close to 75 percent by weight. They serve as a surface on which many microorganisms such as blue-green algae diatoms and nematodes may abound. A variety of invertebrates (annelid worms and clams) thrive in the mud and are in turn fed upon by various shorebirds when the flats are exposed; when the tide is in, diving ducks and fish find nourishment there. Thus, this unique surface serves both essentially terrestrial organisms — the shore birds — and aquatic forms — the ducks and fish, both finned and shell. The fish, of course, are restricted to the shallow water over the flats and are identified under that habitat.

Various algae, both unicellular and multicellular, live on the mud flats. Diatoms and blue-greens represent the former while green algae, e.g., sea lettuce (Ulva sp.), and red algae represent the latter.

Over 100 species of invertebrates have been collected from San Francisco Bay muds. Some of the more important ones are listed below:

Roundworms or nematodes
Ribbon worms or nemerteans

Segmented worms or annelids
- (Neanthes succinea)
- (Nercis diversicolor)

Crustaceans
- Barnacles (Balanus spp.), not living in the mud but on nearby objects
- Shore crabs (Hemigrapsus spp.)
- Commercial crab (Cancer magister)

Molluscs
- California horn snail (Cerithidea californica)
- Moon snail (Polinices Lewisi)
- Mud snails (Nassarius mendicus)
- Sea slugs or nudibranchs
- Bay mussel (Mytilus edilis)
- Ribbed mussle (Modiolus demissus)
- Oysters (various genera)
- Bent-nosed clam (Macoma nasuta)
- Soft shell clam (Mya aranaria)
- Japanese littleneck clam (Tapes semidecussata)

Figure G-1 shows a generalized description of the water areas adjacent to the airport. Figure 2-6 shows a portion of the proposed wildlife refuge in San Mateo County as related to existing aircraft flight paths.

Wild plants and animals abound in the San Francisco Bay region; over a thousand different kinds of higher plants and several hundred birds and mammal species are present. If all the invertebrates were included, the list of animal species would probably run into the tens of thousands. Their sensitivity to noise and air pollution is essentially unknown.

A clear relationship between wildlife and aircraft noise and operations has not been established. Information is only recently becoming available on the effects of sound on living organisms. One report indicated an increased wheat plant size when the plants were subjected to sound frequencies between 5,000 and 300,000 cycles per second.

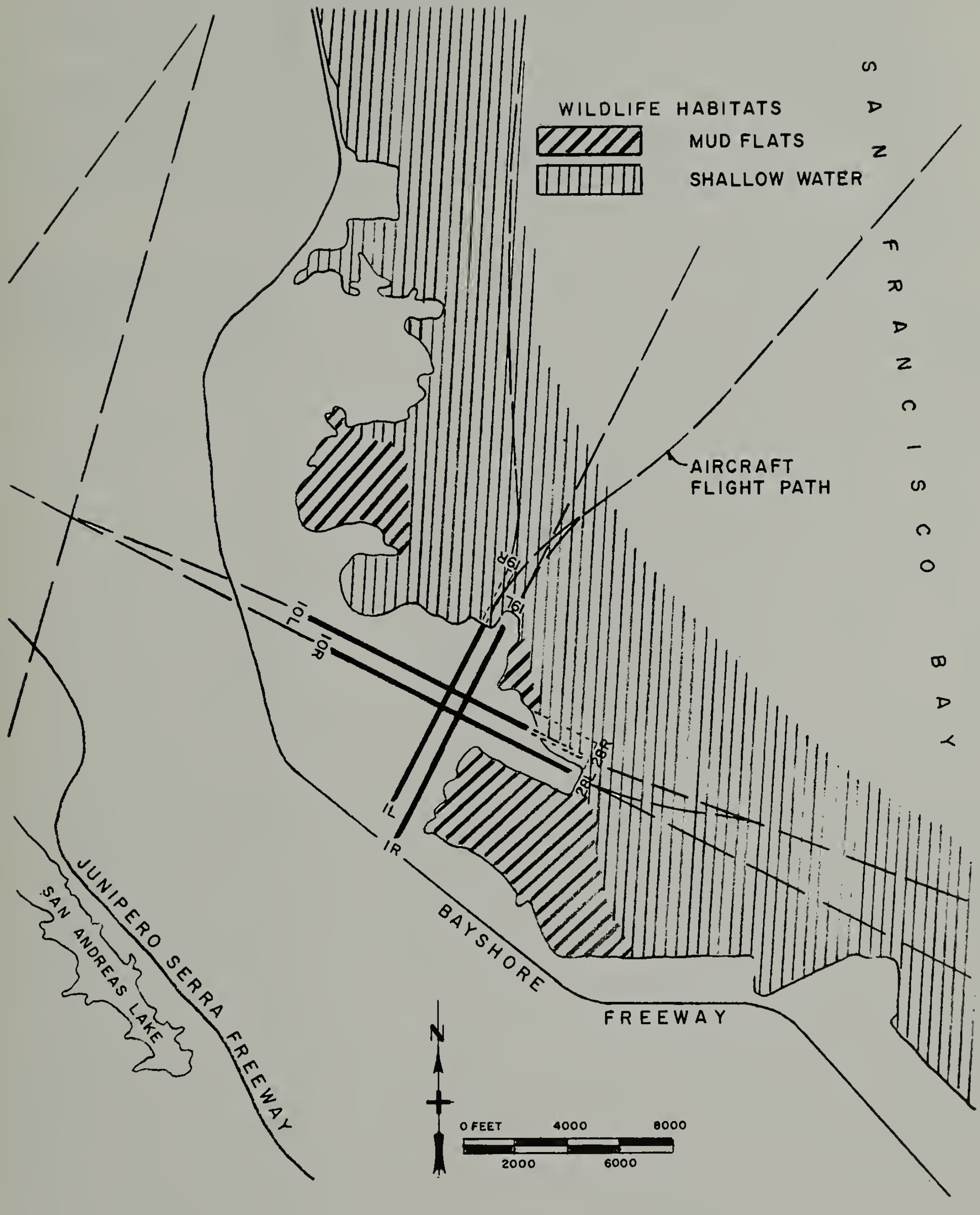
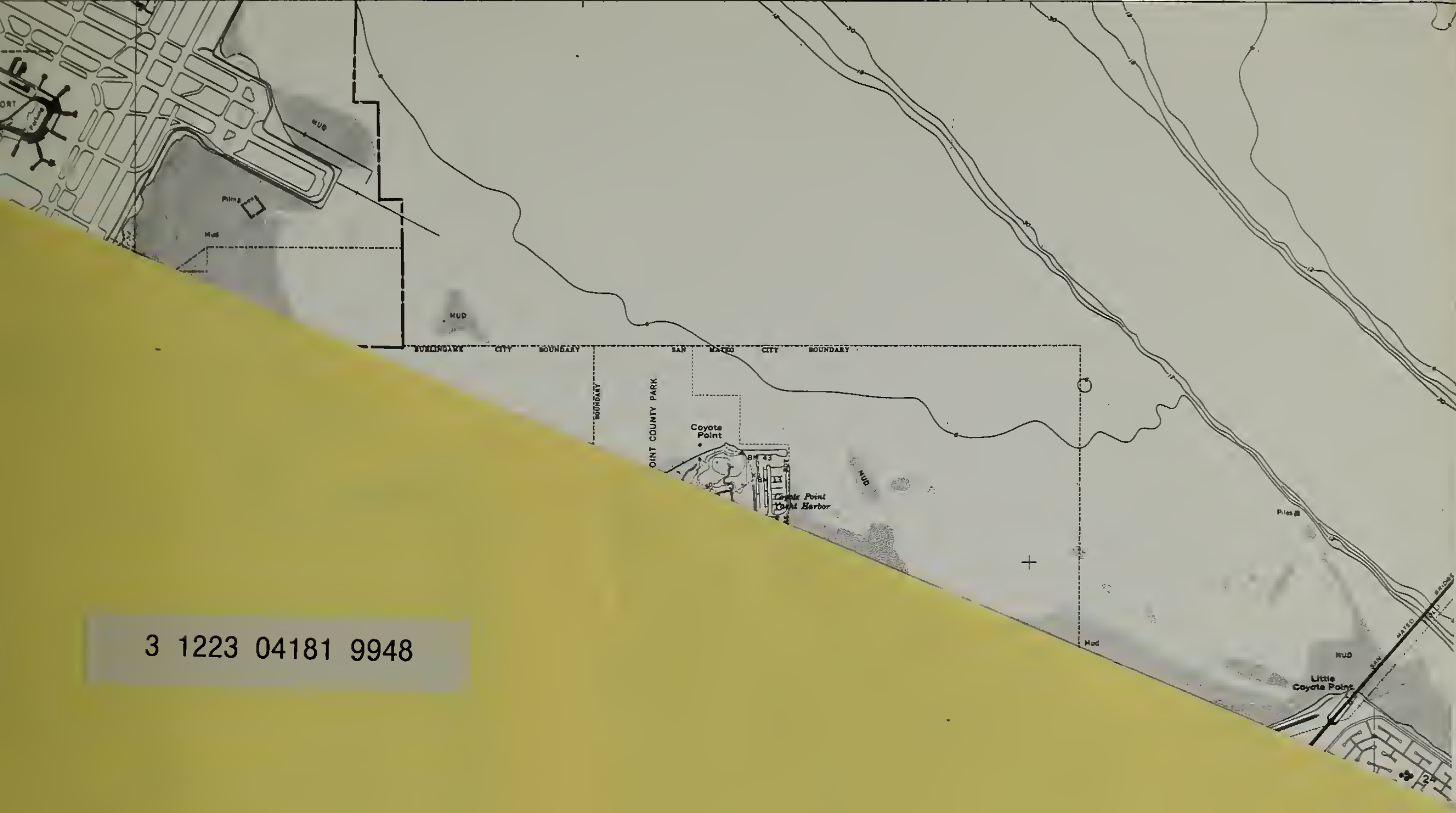
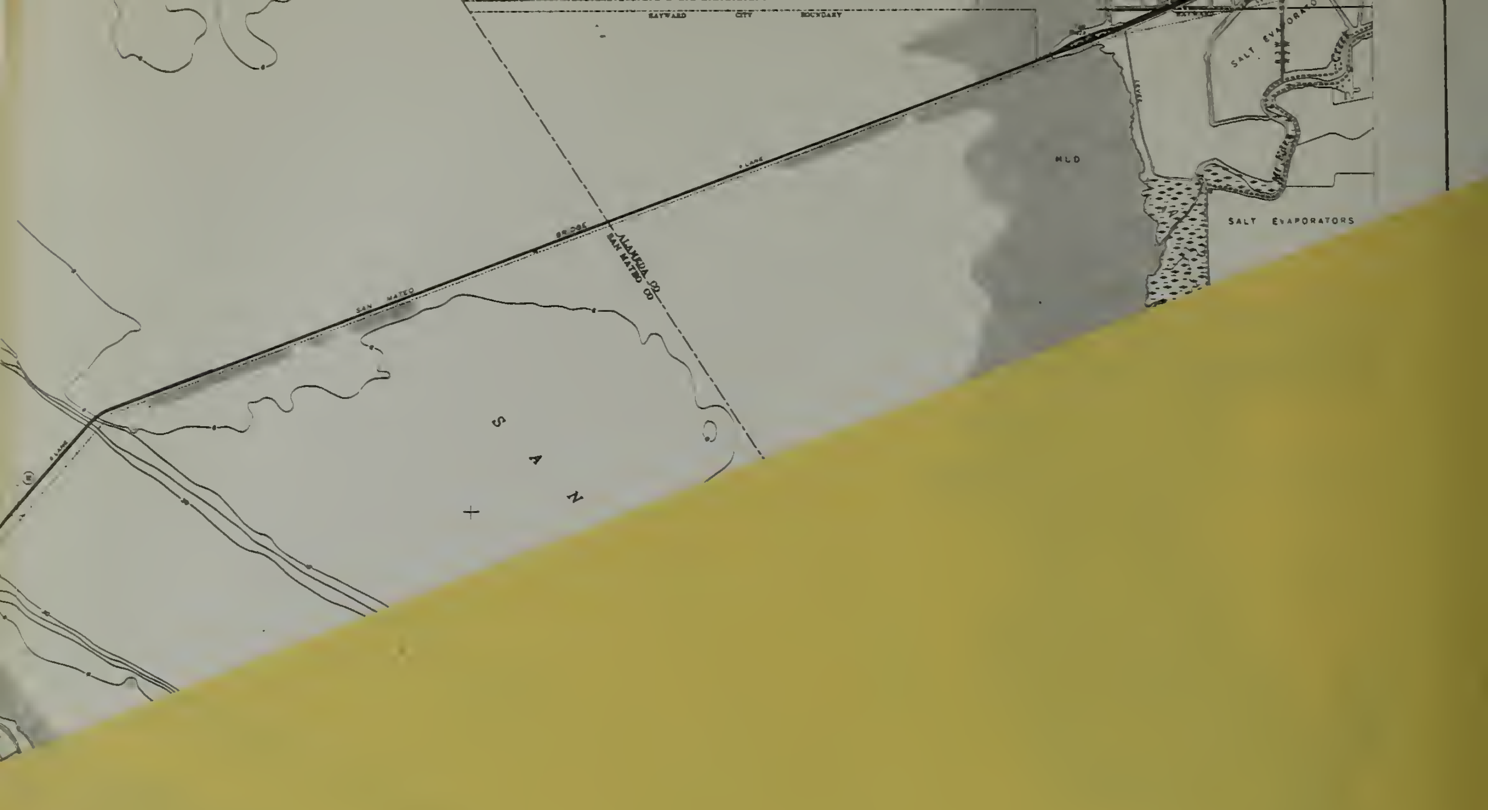


Figure G-1. Wildlife Habitats near San Francisco International Airport

An evaluation of the impact of the airport expansion on wildlife cannot be made in a quantitative manner. However, it is shown elsewhere in this environmental impact statement that air pollution is expected to decrease compared to 1970 levels, noise is expected to be less compared to 1970 levels, and waste discharges will be "cleaner" compared to 1970 levels; thus, the 1985 environment will be better than that of 1970.


BURLINGAME CITY BOUNDARY
SAN MATEO CITY BOUNDARY
Coyote Point
Coyote Point Yacht Harbor
Little Coyote Point
MUD



HAYWARD CITY BOUNDARY
SALT EVAPORATORS
MUD
SALT EVAPORATORS
SAN MATEO
BRIDGE
ALAMEDA CO
SAN MATEO CO
S A N